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ABSTRACT

An analysis of the Dinka (Sudan) vowel system consists of: (1) an overview of Dinka phonological structure, including the phonological sentence, the phonological word, the syllable, and the consonantal and vocalic features of the sound system; (2) an examination of breathy versus nonbreathy vowels, including a review of previous research using a variety of approaches and a discussion of physical, lexical, and grammatical aspects of the two vowel types; (3) a discussion of the acoustic characteristics of breathy and nonbreathy vowels; (4) an analysis of tone; (5) a discussion of vowel length; and (6) an examination of the role of centralized vowels. (MSE)

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DINKA
VOWEL SYSTEM

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VOWEL SYSTEM

Job Malou

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CONTENTS

PREFACE.....ix

1 INTRODUCTION.....1

2 AN OVERVIEW OF DINKA PHONOLOGICAL STRUCTURE.....8

2.1 The Phonological Sentence.....8
2.1.1 Statement.....8
2.1.2 Imperative.....9
2.1.3 Subordinate Clause.....9
2.1.4 Interrogative.....9

2.2 The Phonological Word.....9

2.3 The Syllable.....10
2.3.1 Syllable Types.....10
2.3.2 Syllable Distribution.....15

2.4 The Sounds.....18
2.4.1 Consonants.....18
2.4.2 Vowels.....20

3 BREATHY VERSUS NONBREATHY VOWELS.....22

3.1 Previous Work on Dinka.....22
3.1.1 Orthographic Approach.....23
3.1.2 Linguistic Approach.....24
3.1.3 Vowel Harmony Approach.....26
3.1.4 Recent Analysis.....28

3.2 The Breathy and Nonbreathy Vowel Problem.....31
3.2.1 Physiology of Breathy and Nonbreathy Vowels.....31
3.2.2 Lexical-level Contrast between Breathy and Nonbreathy Vowels.....35
3.2.3 Grammatical Roles of Breathy and Nonbreathy Vowels.....38

4 ACOUSTIC CHARACTERISTICS OF BREATHY AND NONBREATHY VOWELS.....49

5 TONE.....57

5.1 Tone Background.....57
5.2 Tone in Dinka.....59
5.3 Vowel Distribution in Relation to Tone.....62
5.4 Tone Functions.....64

6 VOWEL LENGTH.....66

6.1 Long Vowels at the Lexical Level.....67
6.2 Distribution of Long Vowels in Relation to Consonants.....68
6.3 Distribution of Long Vowels in Relation to Tone.....68
6.4 The Function of Long Vowels at the Grammatical Level70
6.4.1 Third Person Singular/Plural Distinction.....70
6.4.2 Singular/Plural Noun Formation.....71
6.4.3 Prepositional Substitution.....71

7 CENTRALIZED VOWELS.....74

7.1 Centralized Vowels and Unreleased Consonants.....75
7.2 Centralized Vowels at the Grammatical Level.....76

8 SUMMARY AND CONCLUSION.....78

APPENDIX.....81

BIBLIOGRAPHY

ILLUSTRATIONS

1. Nilo-Saharan language family tree....4
2. Dinka consonants....19
3. Dinka nonbreathy vowels....21
4. A seven-spoke vowel diagram....24
5. Relative positions of the larynx....32
6. Plurality alternations of nouns....39
7. Verb/verbal noun alternations....43
8. Vowel heights....46
9. Possessive noun alternations....47
10. Frequencies of first two formants of breathy and nonbreathy vowels....50
11—17. Sonagrams for breathy and nonbreathy vowels....53-56
18. Patterns of contour tracings....62
19. Formant plots for three Dinka speakers....83

Maps

1. Southern Sudan showing Dinka habitat....2
2. The area of Western Nilotic Languages....5

Tables

1. Air impedance in seconds....34
2. Some plurality alternations of nouns....40
3. First and second formant frequencies in Hertz....49
4. First speaker....81
5. Second speaker....82
6. Third speaker....82

PREFACE

This study addresses one of the oldest topics in language analysis--the sound system. While in the current linguistic approach a thorough analysis of the sound system is a prerequisite for a language to be written, the procedure at the time Dinka was first written was somewhat different. This difference is reflected in some aspects left unresolved in the analysis of the Dinka vowel system, such as a lack of a precise definition of breathiness and the role that it and other vowel qualities play in the language. This study is thus a response to the heretofore unresolved aspects of the analysis of the Dinka language.

Of the eight chapters in this study, the first two provide the background needed for an adequate understanding of the remainder. The third discusses physiology and definition of vowel breathiness along with the role of breathiness in the language, and the fourth presents acoustic data. These are followed by a discussion of the importance of tone, vowel length and vowel centralization. The investigations undertaken in the course of this study indicate that breathiness is distinctive and that there are seventy-eight distinct vowel sounds in Dinka.

My decision to undertake this study was largely due to the encouragement given me by Wanda Pace. I am deeply indebted to her for providing me with copies of previous work done in Dinka and related languages, and the manuscripts of the current analysis of Dinka by Duerksen and Agany (1982).

I am grateful to Donald Burquest who not only cultivated in me an interest in phonology, but encouraged me to take a brave stand on this topic which is becoming of concern in

linguistic circles. Special thanks are due to Jerry Edmondson for his personal interest and enthusiasm as well as for the time he spent in finding the instruments needed for the experiment, without which this study would have been a subjective work.

The many hours Kathy Niver devoted to the initial typing and preliminary editing of my work I acknowledge with much gratitude. Her patience, diligence, and high quality of work made it possible to present this complex material neatly.

Finally, I wish to thank the Dinka brothers and sisters in the San Francisco Bay area. Cuir and Paulin Riak not only entertained me, but arranged meetings with those from whom I needed data and other help. Aduolrial Kuck Tueny and Andrew M. L. Deng articulated the minimal pairs for the analysis of the breathy/nonbreathy opposition in the Dinka vowel system. Their special contribution to this work is much appreciated.

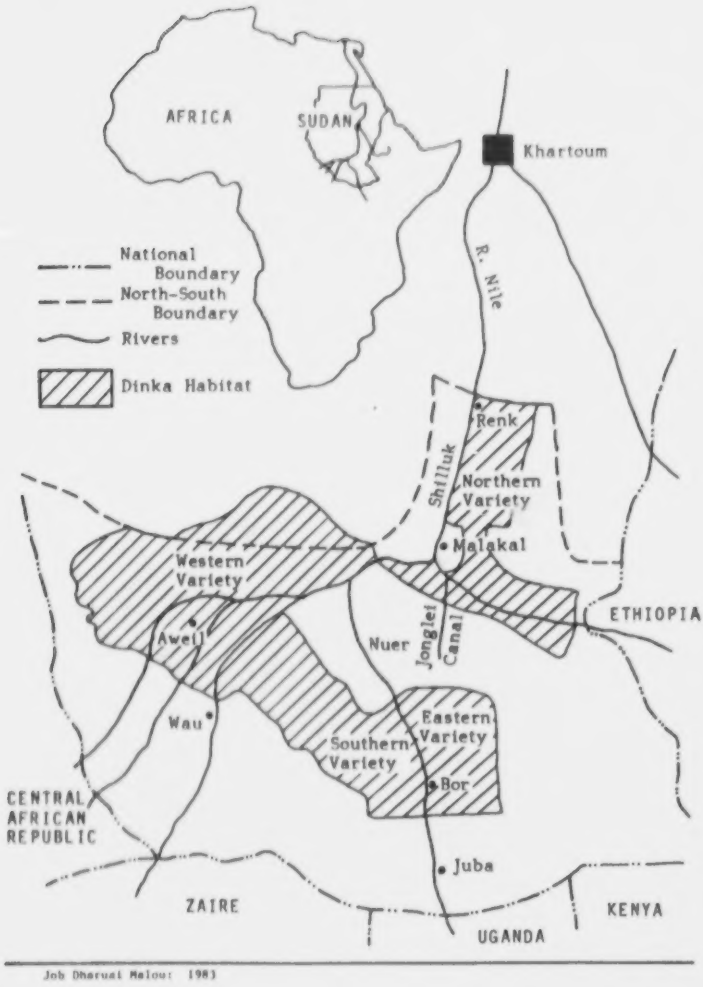
1 INTRODUCTION

1.1 Background

Dinka is the first language of at least two million people who call themselves Jyɛŋ or Mwɔ̃jäŋ. The name they are best known by is Dinka, which herein also stands for the language, but they prefer to call it Thwɔŋjäŋ (literally, 'mouth of Jyɛŋ'). With only the Nuer interruption between 9-1/2° north latitude and 8° north latitude (see map 1), the Dinka people live in south central Sudan in the area along the White Nile River and its tributaries, from Renk in the north to Bor in the south and from Bor in the east to Aweil in the west.

Dinka falls into four major language varieties: Eastern, which is Bor based; Northern, known as Padaŋ, which is Doŋjɔl based; Southern which is Agar based; and Western which is Rek based. These are the varieties in which translations of the Bible or some primers have been written. There are minor variations within each major group. However, the differences that exist among the major groups, although greater than those within each major group, do not challenge the unity of an analysis that covers the whole Dinka language.

There is no recorded history as to when and from where the Dinka people came to their present location. In its present manifestation, the language with which Dinka is most closely related is the Nuer. The two form a complex of sister strains that have descended from a common ancestral language. Just how closely Nuer with its varieties is



Map 1. Southern Sudan showing Dinka habitat

related to Dinka with its varieties has not been determined with certainty.

The Dinka and the Nuer form one subdivision of Western Nilotic. Burun is the second subdivision. The Shilluk, Anuak, Jur, Bor, Acholi of Sudan, the Luo of Kenya, and the Lango and Alur of Uganda form the third subdivision. Western Nilotic is itself a subbranch of Nilotic which, in turn, is a branch of the Eastern Sudanic division of the Chari-Nile subfamily of the Nilo-Saharan language family, based on Joseph H.Greenberg's *The Languages of Africa* (1963). The extent of the Western Nilotic languages as a whole is essentially the environs of the White Nile River and its tributaries from Renk in the north to Lake Kyogo in the south (12° north latitude to 2° north latitude) and just to the northeast of Lake Victoria. (See map 2 for an approximate location of each language.)

According to Ogot (1967), the Luo language groups, referred to as Southern Luo and located in the extreme south of the environs of the Nilotic languages, arrived in their present location about five centuries ago in the first series of migrations from the north. According to Ogot, these migrations were a part of a large dispersion of the Nilotic peoples over many centuries from which groups split off and settled along the way. As these migrating groups diverged from each other, dialect differences that gave birth to different languages developed as the groups came into contact with the speakers of alien languages that influenced their own (see fig. 1).

The influence of alien languages on the various Nilotic languages has not been widely discussed. Rather, it is the relationship among these languages that has been attracting attention. Of all the similarities that linguists say exist among these Nilotic languages, the similarities of vowel systems are outstanding. All linguists agree that the vowel systems of these languages comprise two phonological categories or sets, and that these categories are distinguished by voice quality. The nature of this voice quality difference has not been clearly defined (Crazzolara 1933, Huntingford 1959, Nebel 1948, Welmers 1973). These two sets of vowels have been variously described in the following subjective and impressionistic ways:

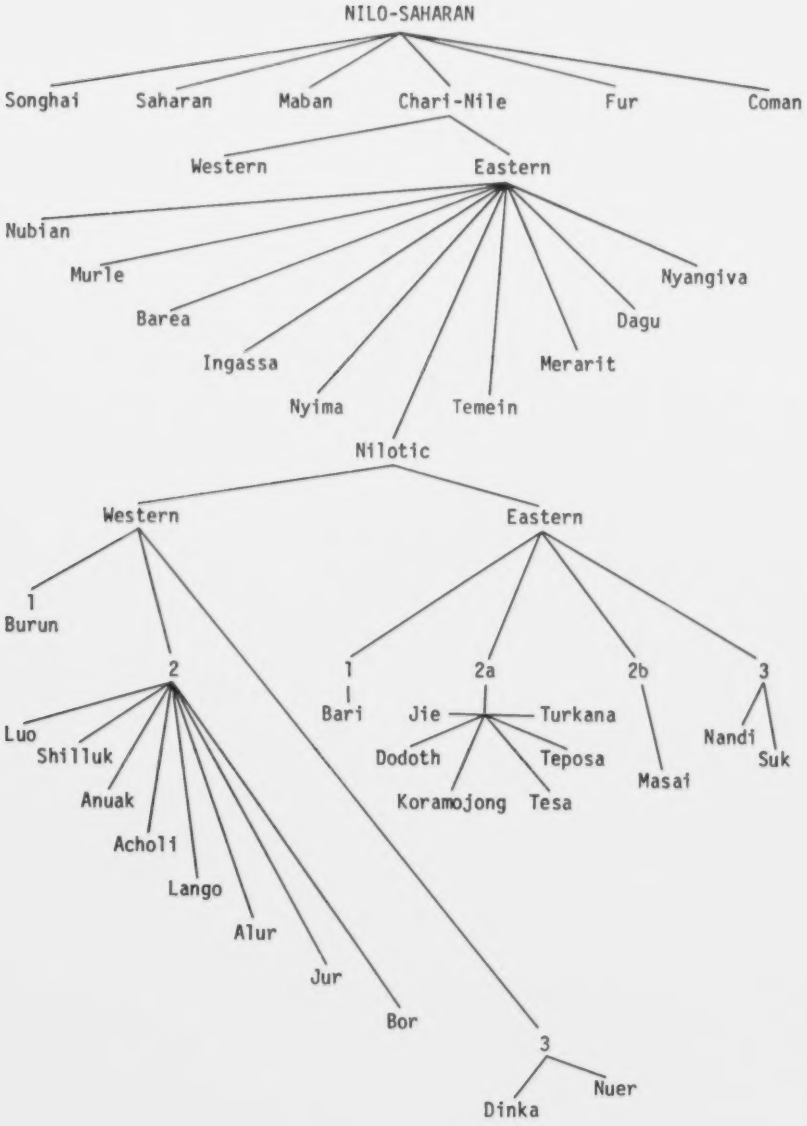
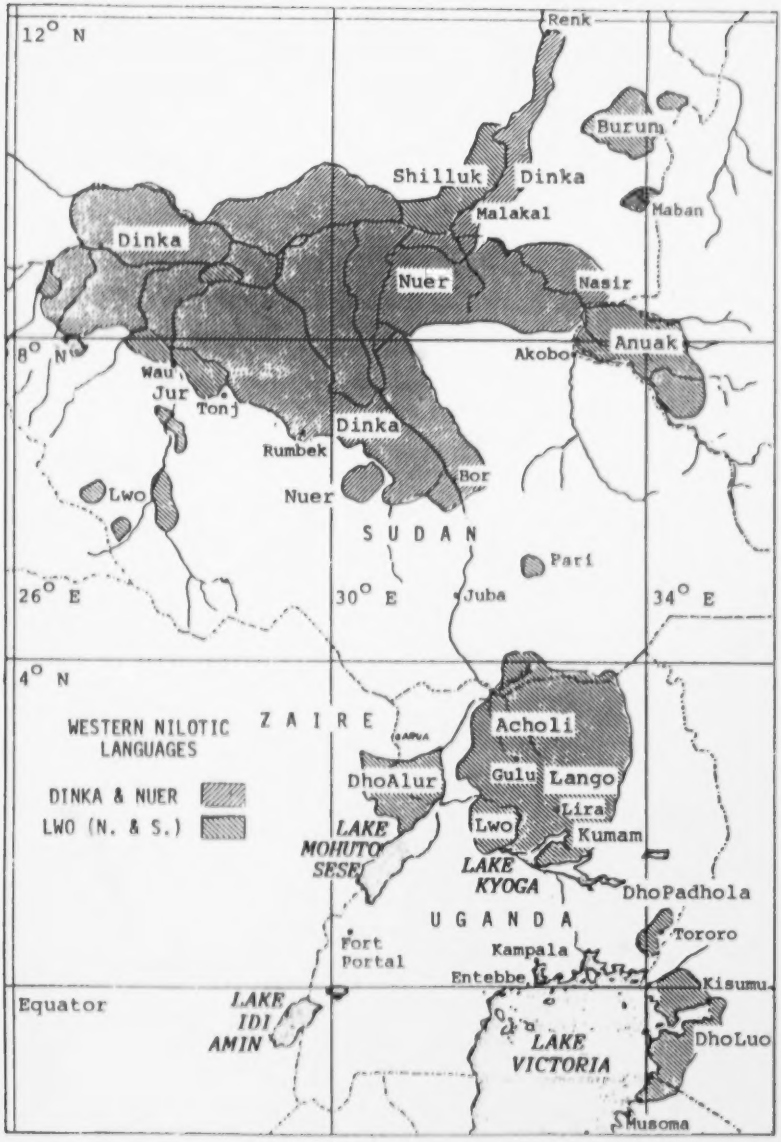


Figure 1. Nilo-Saharan language family tree



Map 2. The area of Western Nilotic languages

"hard" vs. "hollow"
"tense" vs. "lax"
"creaky" vs. "breathy"
"open" vs. "close"
"brassy" vs. "muffled"

One group or another of the linguists uses one or two of the terms *hollow, close, tense, muffled,* and *breathy* to describe one of the phonological sets of the vowel system and one or two of the terms *hard, open, lax, brassy,* and *creaky* to describe the other set. An example is the following (Tucker and Bryan 1966:402-3):

> An outstanding characteristic of these languages is the presence of both 'hard' and 'breathy' (or 'hollow') Voice Quality in the pronunciation of vowels, diphthongs, and semi-vowels.... 'Breathy' = pronounced with open pharynx.... accompanied by a voiced aspiration.... Non-breathy vowels are pronounced with varying degrees of pharyngeal contraction....

From the preceding we can gather that there is a need to pursue two lines of investigation in order to definitely settle the question regarding vowel distinctions in Dinka: first, to study and precisely describe the nature of the voice quality difference between the two categories; and second, to describe breathy vowels with greater precision than heretofore undertaken. I have sought in this work to meet the above needs, and in addition, to clear up the uncertainty of the status of these vowel variants as expressed by B. L. Hall et al., "African Vowel Harmony Systems" (1974:241):

> There are few descriptions of Nilotic languages which give an adequate account of their vocalic systems and often one is in doubt as to whether one is in fact dealing with two vowel series or simply with cases of allophonic variation.

1.2 The Scope of This Work

As a result of such doubts, this discussion has been organized in a way that reflects the aim to resolve the problem. Considerable attention is given to breathy vowels in chapters 3 and 4. The sketch in chapter 2 of the phonology of Dinka with an emphasis on the vowels is basically a framework for the later vowel treatment. Sources include the

author's native knowledge of the language, reinforced by technical studies previously done on Dinka and its related languages, as well as those of other languages having similar vocalic phenomena. The influence of these different sources is reflected in different ways as pointed out during the course of this study. It is hoped that this contribution to Dinka language study will settle long-standing issues through acoustic analysis as well as through perceptual and impressionistic descriptions of the Dinka vowel system.

The data used in determining relative positions of the breathy and normal vowels on the vowel chart have been analyzed with both acoustic and articulatory techniques. The acoustic analysis has been restricted to breathy vowels because it is in this area that most linguists, if not all, have expressed dissatisfaction with the descriptions they have made of the Dinka vowel system. While with the acoustical analysis vowel positions may be objectively determined, this analysis can never totally replace the trained ear.

Following the sketch of the entire system of Dinka phonological structure, chapters 3 and 4 describe breathy vowels in detail. They present a clear definition of them and discuss the nature of voice quality difference. On this basis, argument is given against the allophonic variation treatment of breathy vowels. Subsequent chapters treat tone, vowel length, and vowel centralization; then all is summarized and conclusions stated.

2 AN OVERVIEW OF DINKA PHONOLOGICAL STRUCTURE

One important component of an element of truth is its integration within a large framework. Therefore as a minimum, it is appropriate that a treatment of the Dinka vowel system begin with a sketch of Dinka phonological structure. When observed and reported data can be viewed within an integrating framework, one may begin to arrive at an understanding.

The phonological treatment here is not intended to be exhaustive. It is rather an outline only sufficiently detailed to serve as a framework for the main treatment of the vowel system in Dinka. Matters of juncture, stress, and intonation, which could be discussed under syntagmatic phonology and emphatic features, are not of concern in this discussion. Suffice it to say here that the phonological hierarchy of the Dinka language may be thought of as comprising the following: sentence, word, syllable, and sounds.

2.1 The Phonological Sentence

Described in terms of its elements and its characteristic features, the *phonological sentence* in Dinka is the unit of intonation placement in the phonological hierarchy and is obligatorily bounded by pause. As in other Nilotic languages, there are four types of sentences: statement, imperative, subordinate clause, and interrogative.

2.1.1 Statement. Phonologically the statement sentence type is characterized by a general downdrift.

(1) ɣɛn ɲɔi thäk tök lɔc
I have goat one choose
'I have chosen one goat.'

2.1.2 Imperative. Phonologically, the imperative sentence type is characterized by a rising pitch at the beginning and a downdrift throughout.

(2) ɣäthë thök bey
take goats home
'Take the goats home.'

2.1.3 Subordinate Clause. Phonologically the subordinate clause sentence type is characterized by an intermediate rising pitch that is followed by a downdrift throughout.

(3) na tʷeñ deŋ, ke rör aabi pur
if snap rain then men will cultivate
'If it rains, men will cultivate.'

2.1.4 Interrogative. Phonologically the interrogative sentence type is characterized by general downdrift throughout and final falling pitch.

(4) ci Majak la bey
has Majak go home
'Has Majak gone home?'

2.2 The Phonological Word

Described in terms of the elements distributed in it and the features which characterize it, the *phonological word* is the unit of stress placement in the phonological hierarchy. Each phonological word has one and only one stress. The factors that condition stress have not been studied and, as mentioned, are not the concern of this discussion. It is clear, however, that stress is neither contrastive nor used at all in connection with semantic emphasis in Dinka.

The final margin of the phonological word is characterized by potential pause. The phonological word is the level of distribution of the syllable: one syllable is stressed in each word.

(5) a. aca 'yäṯ
I-have-it take
'I have taken it'

b. 'mʷɔc meṯ
give child
'give the child something'

c. 'mony dït
man old
'old man'

d. 'yɔ̈k lᵊac
cows pregnant
'pregnant cows'

e. 'lec
teeth
'teeth'

2.3 The Syllable

Described in terms of the elements distributed in it and the features that characterize it, the *syllable* in Dinka is the unit of tone placement. Every syllable carries one and only one tone.

Every syllable contains one and only one highest point of sonority, the vowel. This highest point of sonority is called the nucleus of the syllable. The nucleus may be preceded and followed by marginal units, which are consonants.

2.3.1 Syllable Types. On the basis of the different syllable margins, syllable types are established. In Dinka there are three syllable types: V, CV, CVC, illustrated by the following examples:

(6) a. V: ë 'with, to, of'
a.dït 'they are big'
e.ye 'he used to'

b. CV: ca 'milk'
yi 'your _____ (any part of the body)'
ye '3rd person (acc.)'
ku 'and'
dɛ̈ 'another'
yo '1st person pl(acc.)'

c. CVC: mac 'fire'
nak 'feathers'
pur 'hoe'
tik 'woman'
kɔc 'people'
rɛ̈c 'fish'
lëc 'tooth'
ror 'forest'

The V syllable type has neither onset nor coda syllable margin. The vowel functioning as the syllable nucleus in a V syllable is realized as shorter or longer than the vowel in the following CV or CVC syllable, either within the same phonological word or across the phonological word boundary. The nucleus vowel differs in tone from the vowel of the following syllable within the same phonological word, but not necessarily with one across word boundary.

(7) a. Within a phonological word

...CV mét̨ ā.cá mʷɔ̈ɔ̈t̨
child has-me greeted
'The child has greeted me.'

...CVC ɖɔ̈k ālɔ́k àlàt̨
boy is-wash clothes
'The boy is washing clothes.'

b. Across word boundary

...#CV ñá ājáy ë cá
girl is-refusing of milk
'The girl is refusing milk.'

..#CVC yʷɛ̈n ātɔ̈ ë wéŋ ŋòm
rope is-present in cow front (head)
'The rope is in front of the cow.'

In a word of the CV syllable type, /w y b p m n ŋ r d t l k g c/ may function as onset margin. The following are the vowels that occur as nuclei in CV syllables:

(8)	a.	/ï/	yï	'you (obj.)'
	b.	/e/	ke	'with'
	c.	/ë/	tënë	'from'
	d.	/ɛ/	dɛ	'another'
	e.	/a/	lajik	'purity'
	f.	/ɔ/	atɔ	'is present'
	g.	/u/	ku	'and'

The CVC syllable type may contain any consonant functioning as the onset margin and any vowel as nucleus but with three restrictions: (a) if the onset is y, high vowels do not occur; (b) if the onset is ŋ, the high back vowel does not occur; (c) if the onset is ŋh, the high front vowel does not occur. As for the coda margin of this syllable type, only the following consonants fill it: /p, ţ, t, c, k, m, ŋ, n, ñ, n, l, r, w, and y/.

(9)	a.	rap	'sorghum'
	b.	meţ	'child'
	c.	pam	'clapping'
	d.	tɔñ	'pot'
	e.	rel	'anthill'
	f.	läy	'animals'
	g.	lit	'sands'
	h.	pur	'hoe'
	i.	mëŋamääl	'lamb'
	j.	rïŋ	'meat'
	k.	rec	'fish (pl)'
	l.	tik	'woman'
	m.	raan	'person'
	n.	lɔw	'bamboo'

In Dinka, high vowels occur in combination with consonants, filling the onset slots of syllables. In such occurrences the onset stands suspect of being a consonant cluster if the high vowel is considered as a consonant; or, the syllable nucleus stands suspect of being a sequence of vowels if the high vowel is treated as a vowel. However, the interpretation here given to these vowels is that they occur as a consonantal release giving the consonant a contrastive value. In other words, the high vowel together with the preceding consonant forms a unit. I will treat the high vowel

as a prosody that gives the preceding consonant a value contrastive to its unpalatalized or unlabialized value (see the examples in 10). The high front vowel occurs as the release palatalization, and the high back one occurs as the release labialization.

The feature of *labialization*, treated as a consonantal release, has a wide distribution in Dinka. With the exception of ŋ, and ɣ, all consonants in Dinka occur with labialization. All the vowels, except the high and mid nonbreathy back vowels, may occur after a labialized back consonant. The following examples show the occurrence of vowels after consonants with the labialization feature and the contrast between the labialized and nonlabialized consonant:

(10)	a.	/i/	tʷil	'desire for something'
			til	'to be jealous'
		/ï/	kʷïn	'food'
			kïn	'here it is'
	b.	/e/	lʷek	'shaking'
			lek	'kind of fish'
		/ë/	lʷëk	'cattle barns'
			lëk	'pestles'
	c.	/ɛ/	kʷɛṭ	'satisfaction'
			kɛṭ	'stepping over'
		/ɛ̈/	gʷɛ̈t	'beads'
			gɛ̈t	'writing'
	d.	/a/	kʷac	'leopard'
			kac	'to bite'
		/ä/	kʷäṭ	'package'
			käṭ	'unearthing something'
	e.	/ɔ/	kʷɔl	'wild cucumber'
			kɔl	'dodging'
		/ɔ̈/	ɖʷɔ̈k	'to return to'
			ɖɔ̈k	'boy'

Like the feature of *labialization*, the feature of *palatalization* has a wide distribution. With the exception of ɣ and ŋ, all the consonants occur with the feature of palatalization. With the exception of the high vowels and the mid nonbreathy back vowel, all vowels occur after palatalized consonants. The following examples show the occurrence of a vowel after a consonant with the palatalization feature, and the contrast between a palatalized and unpalatalized consonant:

(11)	a.	/e/	lʸek	'to swallow'
			lek	'they went'
	b.	/ë/	ţʸëk	'marriages'
			ţëk	'fix the fracture'
	c.	/ɛ/	rʸɛm	'blood'
			rɛm	'age groups'
	d.	/ɛ̈/	rʸɛ̈c	'mice'
			rɛ̈c	'fish'
	e.	/a/	ţʸal	'spoon'
			ţal	'cook (command)'
	f.	/ä/	rʸäk	'shrine'
			räk	'milking'
	g.	/ɔ/	dʸɔl	'area back of the knee'
			dɔl	'laughing'
	h.	/ɔ̈/	ţʸɔ̈k	'nearness'
			ţɔ̈k	'goat'
	i.	/ö/	bʸök	'hides'
			bök	'act of throwing'

The treatment proposed here of high vowels in combination with consonants as filling the onset slots of syllables is in the light of the following facts:

(1) The category *semivowel* has been historically recognized as distinct from both consonant and vowel categories (cf. Ladefoged 1975:205-7).

(2) In Dinka such elements have a wide range of distribution in terms of preceding consonantal and following vocalic elements.

(3) Neither initial nor final consonant clusters occur in Dinka. Nor do vowel clusters occur. It is, therefore, justifiable theoretically to treat such elements as neither consonant nor vowel where they occur following onset syllables as margin, but rather as features of the consonantal elements with which they occur; and since they give contrastive value to consonants, they are safely treated here as prosodies. (For a similar analysis proposed for Higi, see Mohrlang 1972:59-60.)

To treat these elements as units, that is, [pʸ] = /pʸ/ and [pʷ] = /pʷ/, would be acceptable, but the number of units would multiply enormously as these features have a wide range of occurrence. For this reason, the treatment of these features as prosodies is a neat, simple way to handle them.

2.3.2 Syllable Distribution. The majority of Dinka words are monosyllablic, the commonest syllable type of these being CVC. Two-syllable phonological words also occur and even three-syllable words are found. However, a discussion of phonological words of whatever number of syllables will not be of further concern aside from seeing how these syllable types and their distribution affect the distribution and, possibly, the nature of the vowels. In other words, one must ask whether both breathy and nonbreathy vowel categories occur in the same syllable types in the same positions.

As shown earlier, all syllable types in Dinka occur as monosyllablic words, although some do so only to a limited extent. Syllable type V occurs as a monosyllabic word only with /ë/ or /e/ as the nucleus, and only /a/ or /e/ occurs as the initial V syllable in a disyllabic or multisyllabic word as in the following:

(12)	a.	V	ë	'of, with, to'
	b.	V.CV	e.ye	'he used to'
	c.	V.CVC	a.gɔk	'baboons'
	d.	V.CV.CV	a.la.la	'name of person'
	e.	V.CVC.CVC	a.lɛŋ.lɛŋ	'swinging'

The syllable type CV occurs as a phonological monosyllabic word with only the vowels that appear in the following examples:

(13)	CV	ca	'milk'
		ye	'3rd person sg (acc.)'
		dë	'another'
		yï	'2nd person sg (acc.)'
		ku	'and'

As the first syllable in a disyllabic word of the shape either CV.CV or CV.CVC, CV has as its nucleus only the vowels in the first syllables in the following examples:

(14)	a.	...CV	ma.në	'now'
			ke.në	'with'
			të.në	'from'
			go.kë	'so they'
	b.	...CVC	ma.bör	'white bull'
			më.ŋeñ	'hot tempered'
			ñï.rit	'stubborn (of females)'

Where it is the second syllable in a disyllabic word in which the first syllable is either CV or CVC, its nucleus is formed by only the vowels that appear in the second syllable of the following examples:

(15)	a.	CV...	kë.da	'where'
			kë.de	'his/hers'
			kë.në	'that'
			kë.dɤ̈	'mine'
			kë.du	'yours'
			të.no	'where'
	b.	CVC...	wɛŋ.d[illegible]	'his cow'
			ţäk.[illegible]	'my goats'
			wɛ̈t.kë	'those fellows'
			yäk.ku	'your cows'

The syllable type CVC occurs as a phonological monosyllabic word and also as a component of polysyllabic words. As a monosyllabic word it takes, as its nucleus, any one of the vowels in the system as shown in the following examples:

(16)	CVC	raŋ 'grave'
		mäţ 'smoking'
		yeţ 'neck'
		rët 'anthills'
		kɛc 'bitterness'
		kɛ̈c 'biting'
		ñin 'eye'
		lïk 'being few'
		ţok 'mouth'
		löţ 'bell'
		rɔk 'fence'
		rɔ̈m 'meeting'
		wum 'nose'

In disyllabic phonological words in which the second syllable is CV, a first-syllable CVC has as its nucleus (for some varieties) any of the vowels:

(17)	...CV		
		rap.ke	'his sorghum'
		yäk.ke	'his cows'
		lec.kʷa	'our teeth'
		lëñ.de	'his stick'
		rɛl.de	'its anthill'
		rʸɛ̈ñ.du	'your age-mate'
		rin.ke	'his name'
		ñïn.ku	'your eyes'
		dom.da	'his form'
		dömˑda	'our catching'
		rɔŋ.du	'your fence'
		rɔ̈m.ku	'we meet'
		wum.dʸɛ̈	'my nose' [1]

When the second syllable is CVC, then the vowel distribution of the first-syllable CVC is the same as in example 17:

(18)	...CVC		
		rap.ken	'their sorghum'
		yäk.ken	'their cow'
		lec.ken	'their teeth'
		lëñ.dɛn	'their stick'
		rɛl.dɛn	'their anthill'
		rʸɛ̈ñ.dʷɔ̈n	'your (pl) cohort'
		rin.ken	'their name'
		ñïn.kʷɔ̈n	'your (pl) eyes'
		rɔŋ.dʷɔ̈n	'your (pl) fence'
		kɔ̈k.kʷɔ̈n	'your arms'
		wun.dɛn	'their cattle camp'

When CVC follows V or CV or CVC, the distribution of the vowels in CVC varies. With V as the first syllable, there is a wide range of possible vowels in CVC. All vowels occur in CVC after V:

1 The Rek and the Agar varieties would not have high vowels in such syllables because the high vowels become features of palatalization (as rinke -> rʸenke, ñirku -> ñʸɛ̈rku) or labialization (see section 3.2.3.4.).

(19) V... e.caɻ 'He walks.'
a.räm 'Praise the Lord.'
a.teñ 'It is exploding.'
a.tëm 'He is cutting.'
a.rɛc 'He is spoiling it.'
a.rët 'He is scrambling (something).'
a.rin 'He is running.'
a.dït 'It is big.'
a.rop 'ashes of dung fire'
a.jör 'joke'
a.lɔc 'voting'
a.yöl 'grass of first spring rain'
a.wuw 'millet (pl)'

With CV or CVC as the first syllable, vowel distribution in CVC becomes limited to some extent. Only /i ï e ɛ ä ö/ occur in CVC after CV.

(20) CV... ma.cär 'black bull'
ma.lek 'brown and tawny bull'
ma.kɛñ 'person's name'
më.til 'jealous person'
mʷö.dïŋ 'tawny-necked bulls'
du.pʸöc 'teacher'

In CVC after CVC, only the following vowels occur: /oo o ä e u è ö/, on long vowels (cf. 2.4.2).

(21) CVC... tʷɔŋ.jäŋ 'Dinka language'
yäk.ken 'their cows'
weŋ.dɛn 'their cow'
mʷɔr.col 'name of person'
nan.cool 'black calf'
yäk.kʷɔn 'your (pl) cows'
ŋʸäkdur 'early morning'

2.4 The Sounds

Dinka sounds are here represented in terms of their inherent consonantal and vocalic features.

2.4.1 Consonants. Dinka has twenty distinctive consonant sounds. Figure 2 shows the position and manner of articulation for nineteen of them, and following figure 2 is an explanation of the twentieth.

Like some of the other Nilotic languages, e.g., Acholi, Shilluk, etc., Dinka has dental consonants (t̪, d̪, n̪), which orthographically are written as th, dh, nh. They are to be differentiated from /t, d, n/. The difference between these series rests in position. While /t, d, n/ are articulated with the tongue tip against the alveolar ridge, [t̪, d̪, n̪] are articulated with the tongue tip against the upper teeth. The following examples show minimal pairs:

(22) a. tim 'tree'
t̪im 'to cut to pieces'
b. dɔl 'laughing'
d̪ɔl 'tall one'
c. nʸɛ̈r 'seeing scornfully'
n̪ʸɛ̈r 'love'

Again like some Nilotic languages, Dinka has pure palatal consonants [c, j, ñ], written orthographically as c, j, ny, which form a palatal series paralleling the bilabial, alveolar, and velar series of consonants. /c/ and /j/ are quite different from English affricates in *church* and *jump*: /c/ and /j/ in Dinka are stops rather than affricates. As for the nasal palatal [ñ] (/ny/), it sounds, according to Tucker (1948:5), as in the French *Boulogne*. Dinka does not have fricatives. Figure 2 shows the positions and manner of articulation for the consonants in Dinka.

		bil.	den.	alv.	pal.	vel.
STOPS	vl	p	t̪	t	c	k
	vd	b	d̪	d	j	q
NASALS		m	n̪	n	ñ	ŋ
LATERALS				l		
FLAP				r		
SEMIVOWELS		w			y	

Figure 2: Dinka consonants

In addition to the nineteen consonants represented in figure 2, there is a twentieth, y, not on the chart because it is difficult to determine its place of articulation. It is greatly influenced by a following vowel. If the following

vowel is nonbreathy, ɣ is nonbreathy; but if the following vowel is breathy, then ɣ will be breathy. Or if the following vowel is rounded, then ɣ will be rounded; it will be unrounded if the following vowel is unrounded:

(23) a. ɣam 'talking in a disorganized manner'
ɣäm 'thigh'
b. ɣor 'to bore'
ɣör 'make a big hole in something'

ɣ is an archaic sound that is not found in cognates in some other Nilotic languages. In some of these languages ɣ has been vocalized, giving rise to long vowels, as shown in the following examples:

(24)	Dinka	Acholi	Gloss
a.	ɣël	eel-o	'to lift'
b.	ɣɛn	aan	'I'
c.	ɣöt	oot	'hut'
d.	ɣäm	eem	'thigh'
e.	ɣɔr	ɔɔr-a	'vale, depression in terrain'

The fact that Dinka has retained ɣ has led to simpler phonotactics. Without the use of ɣ in the language, VC syllable pattern and vowel clusters would be difficult to prevent. In other words, besides preventing the occurrence of the VC syllable type, ɣ breaks up some potential vowel clusters:

(25)			
a.	ayer	'outside'
b.	yëët	'to reach'
c.	ayɛn	'What about me?'
d.	ayɛp	'forcefully'
e.	yaac	'to sell'
f.	ayäɣ	'baskets'
g.	yɔɔc	'selling'
h.	ayɔk	'He is angry.'
i.	ayook	'It is us.'

2.4.2 Vowels Since vowels will be treated in detail in the following chapters, it is sufficient here to point out that Dinka has a system of contrasts relying on seven vowel positions and four dimensions of vowel quality: breathiness vs. nonbreathiness, tone, length, and centralization. The contrastive nature of each of these features, investigated dur-

ing this study, is discussed in succeeding chapters. The seven vowel positions are [i, e, ɛ, a, ɔ, o, u] and they are defined as shown in the vowel trapezoid of figure 3.

Figure 3. Dinka nonbreathy vowels

Example 26 illustrates the contrast among these vowels. The contrast is demonstrated in pairs between sounds that are adjacent in the chart (fig. 3):

(26)	a.	/i/	vs. /e/	rim	'blood (pl)'
				rem	'cohorts'
	b.	/e/	vs. /ɛ/	lʷel	'Say it.'
				lʷɛl	'narration'
	c.	/ɛ/	vs. /a/	pɛl	'craftiness'
				pal	'knife'
	d.	/a/	vs. /ɔ/	rak	'kind of tree'
				rɔk	'fence'
	e.	/ɔ/	vs. /o/	lɔr	'You go.'
				lor	'Meet him.'
	f.	/o/	vs. /u/	moc	'man'
				muc	'shooting'

Vowels with diacritics (breathy vowels) do not appear on the chart in figure 3. The reason for this is that those who first described the Dinka vowels had their doubts about the existence of breathy vowels. Therefore, many previous investigators left them unmarked. This is what has inspired this study as mentioned earlier. My main aim is to show that breathy vowels are distinctive and also to show their position on the chart. However, since the words so far used contain these breathy vowels, I have had to mark them before showing that they are distinctive. Their positions on the vowel chart remain to be determined through the use of instrumentation.

What follows is the treatment of the vowel qualities, breathiness vs. nonbreathiness, tone, length, and centralization, with a look at vowel harmony. The discussion will begin with the breathy vowels because they are considered to be the area most in need of study.

3 BREATHY VERSUS NONBREATHY VOWELS

Breathy is one of the adjectives that, together with *hollow*, *muffled*, *close*, and *tense*, linguists use to describe one of the two phonological vowel categories in Western Nilotic vowel systems. To describe the other category, they use such term as *nonbreathy*, *hard*, *brassy*, *open*, and *lax* (Jacobson 1978). Such adjectives are used by different linguists, each linguist using one or another pair of adjectives to describe his impressions about the Western Nilotic vowel systems. Jacobson (1977), for example, uses *muffled* vs. *brassy*, and Tucker and Bryan (1966) alternate *hard* vs. *breathy* and *creaky* vs. *brassy*. Here I use *breathy* vs. *nonbreathy* to refer to these two vowel categories in Western Nilotic languages.

The main concern in this discussion is *breathy* vowels, rather than both *breathy* and *nonbreathy*, because *nonbreathy* is considered "normal," or "modal voice" (Catford 1977). The nature of nonbreathy phonation does not evidence any remarkable feature, though from time to time it will be useful as a contrast. Thus, I begin by concentrating on the notion of breathiness by offering a review of what some linguists have said about breathiness in the Dinka vowel system in general.

3.1 Previous Work on Dinka

Linguists who have worked on Dinka fall into four categories. The first category is the missionaries whose aim was to make an analysis sufficient for a functional orthography. I shall call their approach, for ease of reference later, *the orthographic approach*. The second category is the linguists who wanted to contribute to linguistic knowledge. This I shall refer to as *the linguistic approach*. The third

category is the linguists who wanted to confirm or refute theories of vowel harmony; their approach is referred to as *the vowel harmony approach.* Last but not least are those linguists who have recently described breathiness and who are currently working on the analysis of Dinka; I shall refer to their work as *recent analysis.*

3.1.1 Orthographic Approach. The aim of the missionaries was to make analyses that could enable them to develop orthographies for the translation of the Bible. Two missionaries who worked among the Dinkas stand out: a Verona priest by the name of Father Nebel, who worked among Dinka Rek, and Rev. Talmadge Wilson of the Presbyterian Church, who worked among Dinka Padang.

The writings of these men are no longer available to the linguistic world. However, their contributions are reflected in the works of other linguists and in the vernacular work they left behind in the Dinka area. For Father Nebel, the unpleasant encounter he had with breathy vowels is revealed in his marking of breathiness. For example, in one of the primers, *Aɣör ë ŋuan,* he uses *nɛ̈k* 'killing' to differentiate it from *nak* 'feathers', and in his *Dinka Grammar* (1948:40) he employs *dhöl* 'way' and differentiates it from *dhol* 'to take all'. But he stopped at that point. This hesitation indicates Father Nebel's awareness of breathiness but perhaps also the contemporary lack of phonetic sophistication. Perhaps he chose an incomplete treatment because of orthographic economy or because breathiness was a phenomenon whose depth and breadth he was not able to assess.

The work of Wilson is reflected in Welmers's work. From what Welmers (1973) has said, Wilson's encounter with the breathy vowels also made him take note of this phenomenon. His analysis posited three vowel qualities:

(1) very long vowels with an extremely clear, "brassy" quality and extreme articulatory positions;

(2) breathy vowels of intermediate length and somewhat more neutral (i.e., toward central) tongue positions; and

(3) very short, centralized vowels.

Wilson distinguished seven contrasting positions for each of the three types. Thus, his vowel diagram resembles an eight-spoke wheel with the top spoke missing. In the vowel diagram, which Welmers (1973) took over from Wilson, a *macron* indicates length, a *dieresis* indicates breathiness, and a *breve* indicates shortness and centralization (see fig 4).

Figure 4. A seven-spoke vowel diagram showing three Dinka vowel qualities

3.1.2 Linguistic Approach. The linguists whose aim was to contribute to linguistic knowledge were the next to encounter the Western Nilotic vowel systems. Among these linguists, Tucker, Bryan and Welmers stand out.

In M. A. Bryan's *Distribution of the Nilotic and Nilo-Hamitic Languages of Africa* and A. N. Tucker's *Linguistic Analyses* (bound together as one volume) the authors recognize the complicated nature of the Dinka vowel system. They point out the existence of seven vowel-place contrasts as well as the qualities of breathiness and length as contrastive features. The following is Tucker's summary (1948:19):

> (d) A complicated vowel system: on the whole there seem to be seven vowel phonemes, a, ɛ, e, i, ɔ, o, u, with varieties including centralized forms of most of them (varying according to dialect for the most part); diphthongs are very common; vowel length is an important feature.
>
> (e) Voice quality as linguistic feature: there is normal and 'breathy' voice; variations in voice quality may indicate lexical and grammatical distinctions.

In a later work, Tucker and Bryan (1966:402-3) say that the outstanding phonetic feature of the Northern Nilotic languages (i.e., the Northern branch of Greenberg's 1963

Western Nilotic) is that voice quality (breathy vs. hard) seems to act as an independent variable; that is, "almost any vowel may be pronounced with both types of voice quality, depending largely on grammatical context." Tucker and Bryan's analysis (1966) differs from Welmers's vowel wheel analysis in some respects, though recognizing three types of vowels. They disagree with Welmers with respect to the number of positions, assuming eight articulatory positions instead of Welmers's seven, and a distinction of four centralized vowels instead of the seven of Welmers (cf. also Bryan and Tucker 1948).

In his treatment of vowel systems, Welmers (1973:28) opens his analysis with the description of the breathy vowels:

> Among non-Niger-Congo languages, several of the Nilotic languages of the upper Nile Valley have a series of vowels commonly called "breathy." Having heard and attempted to imitate such vowels in Anuak (during a period of a few days in 1950), and having heard them on tape recordings of Nuer and Dinka, I consider the impressionistic label to be a good one. Apparently the voicing of these vowels is such that the vocal cords do not entirely close, permitting the air passing through from the lungs to produce an audibly fricative effect.

Welmers finds Wilson's tentative analysis of the Dinka vowel system remarkable because, if it is correct, the system is quite unlike any other known to him. What he finds remarkable is the treatment of the morphological alternations operating in the analysis. He sees Wilson's analysis of the vowels (see fig. 4) as being reinforced by the morphological patterns quoted here:

> ... alternations between noun singulars and plurals appear to involve most commonly a movement clockwise to the next spoke, but in the same position on the spoke; that is, if the singular has /ü/, the plural has /ö/; if the singular has /ö/, the plural has /ɔ̈/; and so on around until if the singular has /ë/, the plural has /ï/; but if the singular has /ï/, there is no change in the plural (since there is no spoke in the next position clockwise). A less common pattern is precisely the reverse, with alternation in the plural one spoke counterclockwise from the vowel of the singular; if the singular is on the /u/ spoke there is no change in the plural. Still other alternations are one step in or

> out on the same spoke: /ö/ to /ö̱/, /ä/ to /ä̱/ and the like. If the above diagram [i.e., fig. 4] is filled in with lines -- three concentric horseshoes and seven spokes -- then the morphophonemic alternations permit single moves on any line, never more than one space and never across a gap in a line (Welmers 1973:29).

In a conclusion drawn from this observation, Welmers points out that it is impossible to capture the entirely reasonable alternation patterns of Dinka in any convenient set of rules in any contemporary version of generative phonology.

3.1.3 Vowel Harmony Approach. Numerous linguists have employed the vowel harmony approach, but the principal ones are B. L. Hall, R. M. R. Hall, Martin D. Pam, Amy Myers, Stephen A. Antall, Godfrey K. Cherono, and Lawrence P. Sheerin (B. L. Hall et al. 1974; R. M. R. Hall et al. 1975). In their attempt to reconstruct a Proto-Nilotic vocalism in "African Vowel Harmony Systems from the Vantage Point of Kalenjin" (B. L. Hall et al. 1974), these linguists start by examining works such as Ladefoged (1964), Lindau, Jacobson, and Ladefoged (1972), and others who have shown that tongue-root position is an important factor in the phonetic description of vowels and in the phonological description of certain types of vowel alternations. They single out Stewart's work (1967:198), who has specifically shown that tongue-root position provides a simple and natural explanation for a unified treatment of the "cross-height" vowel harmony processes exhibited by African languages. In his account of the vowel system in Akan languages, Stewart has shown that in these languages the vocalic inventory may be divided into two sets, one set being labeled "tense" or "close" and the other "lax" or "open."

These linguists describe "tense" or "close" (our *non-breathy* category) as frequently articulated with a greater degree of muscular tension than "lax" or "open" (our *breathy* category). The feature [advanced tongue root], which they refer to as [+ATR], describes the primary articulatory gesture that has been found to be involved in the production of breathy vowels in Akan languages. In light of the vowel harmony pattern in Akan languages, they go on to examine the Dinka and Nuer data provided by Tucker and Bryan and conclude:

> In Dinka-Nuer it is obvious that vowel harmony still exists since grammatically related forms do show [+ATR] alternating with [-ATR] vowels. However these languages in their present state are predominantly monosyllabic (i.e., have lost final vowels and hence almost all of the conditioning factors) and therefore it is very difficult to show what the rules are (B. L. Hall et al. 1974:254).

One other linguist in this category is Leon C. Jacobson, who has made an extensive investigation of vowel harmony both in the works of other linguists and in his own experiments. In his investigation of the Dinka vowel system for vowel harmony, he distinguishes six degrees of vowel height for front vowels and six degrees of height for back vowels, with four degrees of height for central vowels. However, he casts doubt on his own findings on the grounds that even five degrees of vowel height are still too many at the phonological level. He finds that what is needed in Dinka is another phonological parameter. This leads him into the examination of other features. He examines the Chomsky and Halle (1968) distinctive feature [tense] to find that it cannot be used, because Chomsky and Halle (1968:324) define the feature as follows:

> ... Tense sounds are produced with a deliberate, accurate, maximally distinct gesture that involves considerable muscular effort; nontense sounds are produced rapidly and somewhat indistinctly.

Following this criterion, Jacobson finds that his lower harmony set is tense and his higher harmony set is nontense. However, an examination of another of Chomsky and Halle's criteria establishes his relatively high set as the tense one. This criterion says that tense vowels "are executed with a greater deviation from the neutral or rest position of the vocal tract" (Chomsky and Halle 1968:324) than lax vowels. Thus one definitional criterion is satisfied and the other is not. This calls to his mind the fact that *tense* and *lax* have been used phonologically as cover terms for identifying the different vowel harmony sets found in African languages, a practice that he finds highly confusing since, at a phonological level, it treats as tense a segment which is lax at a physiological level, and vice versa.

Another feature that he examines is "covered/noncovered", suggested by Chomsky and Halle (1968:315) and about which they say:

> We shall assume that covered sounds are produced with a pharynx in which the walls are narrowed and tensed and the larynx raised; uncovered sounds are produced without a special narrowing and tensing in the pharynx.

Jacobson finds that this description does not agree with his findings: a covered sound or one with a dull muffled quality (which is our present breathy quality) occurs with dilated pharynx; with constricted pharynx a brassy quality occurs. So Jacobson's description of the breathy and non-breathy vowels, derived from his findings, would be that breathy vowels are those with dilated pharynx while the non-breathy vowels are those with constricted pharynx.

In conclusion, Jacobson suggests that for Dinka it is necessary to have an auditory-based parameter in addition to the standard articulatory parameters. This second dimension is needed to distinguish the different vowel harmony sets. He suggests the use of *muffled/brassy* instead of terms like *creaky/breathy*, as the latter mix up phonation and perception. (As yet there had been no instrumental evidence of the different modes of vocal cord vibration.)

3.1.4 Recent Analysis. Of the linguists who have recently written about breathy vowels in general and those who are currently carrying out an analysis of the Dinka vowel system, John Duerksen and Salva Agany, now in the Dinka area, have already made some progress. In their unpublished "Introduction to the Dinka vowel system" (1982:3), they identify seven vowel positions and four vowel qualities: length, tone, breathiness, and openness (our centralization). The following is what they say about the breathy vowels in Dinka:

> Breathiness is the third vowel quality. A vowel may be either *breathy* or *not-breathy*. The breathy vowel is marked with two dots above the vowel (V) and the not-breathy is not marked (in the examples below):

	Not-breathy		*Breathy*	
a.	lek	'pestle (sing.)'	lëk	'pestles'
b.	deŋ	'rain'	dëŋ	'rain (pl)'
c.	loň	'group of animals'	löň	'to drop'

> The breathy vowel is produced by opening the vocal cords slightly, increasing the flow of air from the lungs and expanding the pharynx. Breathiness may be felt by placing the fingers on both sides of the pharynx above the larynx. For breathy vowels there is a slight expansion of this region and an increase in vibration can be felt.

There have recently been a number of descriptions of breathy vowels (also called *murmur*). Particularly detailed is the characterization by John Laver (1980). According to him, *breathiness* is a set of qualities determining a mode of glottal vibration different from "normal" vibration, which he calls *modal voice*. He says:

> By comparison with modal voice, the mode of vibration of the vocal folds is inefficient, and is accompanied by slight audible friction. Muscular effort is low, with the result that the glottis is kept somewhat open along most of its length, and the folds never meet on the midline. Because each closing movement of the folds tends to be abortive, the lessened glottal resistance leads to a higher rate of airflow than in modal voice (Laver 1980:132).

Laver goes on to quote the following description of the characteristics of breathy voice by Catford (1977:99):

> ... the sound of voice mixed in with breath. The effect is somewhat like that of sighing. This is *breathy voice:* the glottis is narrowed from its most open position, but not narrowed enough to generate whisper, that is, it is still at considerably more than 25 per cent of its maximal opening, probably, in fact, around 30 to 40 per cent. The vocal folds are vibrating, but without ever closing or, indeed, coming anywhere near closing. They simply 'flap in the breeze' of the high velocity air-flow. The liminal volume-velocity for the production of breathy voice is of the order of 90 to 100 cm^3/s: more commonly, however, it is much faster, around 900 to 1000 cm^3/s.

Based on this, Laver concludes that the notion *breathy voice* involves a type of phonation that can be produced on a very wide range of airflow. He goes on to say that Catford takes the position that most examples of what he would classify as breathy voice use a very high rate of airflow. Catford (1977:99) suggests:

> ... try filling the lungs to capacity and then generating breathy voice for as long as you can. Owing to the high volume-velocity of breathy voice, this probably will not be more than four or five seconds. Breathy voice often occurs when one tries to blurt out a message when extremely out of breath. It is also the phonation type of 'voiced h'.

While agreeing with Catford that breathy voice produced at the lower end of the range of airflow has enough auditorily in common with breathy voice produced at a very high rate of airflow to justify the use of the same identifying label for such voices, Laver takes the position that in normal speaking situations, most examples of breathy voice will use airflow rates from the lower end of the range. He says most speakers with breathy voices will be able to speak relatively continuously, without needing to pause every four to five seconds to draw breath, unlike the speakers Catford describes who use flow rates of up to 1000 cubic centimeters per second.

With respect to laryngeal muscle tension, Laver (1980:133) cites the following adjustments for breathy voice:

(1) minimal *adductive tension* (minimal active contraction of the vocal fold muscles);

(2) weak *medial compression* (weak toe-in of the arytenoid cartilages);

(3) low *longitudinal tension* (low passive contraction of the vocal folds by means of external muscles--cricothyroid).

Moreover, high-pitch breathy voices are rare. Breathy quality is invariably accompanied by limited vocal intensity and/or low pitch.

Also breathy voice can combine with modal voice, which requires only moderate medial compression, but not with other modes of glottal vibration, such as falsetto, whisper, creak, harshness, and ventricular voice. These require a greater amount of medial compression than is compatible with breathiness.

3.2 The Breathy/Nonbreathy Vowel Problem

Much has already been said about the breathy/nonbreathy vowel relationship, representing a preliminary attempt to answer the questions raised in the analysis of the Dinka vowel system by different linguists. What has attracted their attention about the breathy/nonbreathy vowel relationship is covered by three questions:

(1) What is involved in the production of each of the vowel categories in question?

(2) What kind of relationship is there between the two vowel categories?

(3) What linguistic role does the breathy vowel category play in Dinka?

Each of the linguists mentioned has been trying to find answers to one or more of these questions. In the following sections I attempt to provide answers to all three.

3.2.1 Physiology of Breathy and Nonbreathy Vowels. In the production of breathy vowels, the vocal folds are slightly apart along their entire length, but still vibrating (Ladefoged 1975:122); the larynx is lowered, giving rise to increases in length and width of the pharyngeal cavity; the tongue is lowered in the mouth, which in turn gives rise to increase in the volume of the mouth cavity; the velum is raised against the pharyngeal wall. In production an airstream from the lungs passes through the slightly opened glottis and through the enlarged pharyngeal cavity, and on its deflection at the velum into the enlarged mouth cavity there is an audibly fricative effect that is accompanied by a more hollow sound quality resulting from the laryngeal buzzing sound exciting the resonances of both the enlarged pharyngeal and mouth cavities, especially for low round back vowels. Nonbreathy vowels are produced with the body of the tongue domed upward, the larynx at normal position and the vocal folds lying side by side (see fig. 5). The difference in the production of the two sounds can be felt by placing the fingers on both sides of the pharyngeal region, touching also the top part of the larynx to feel its movements while saying the following pairs: *riŋ/rïŋ*, *lec/lëc*, *thok/thök/*, etc.

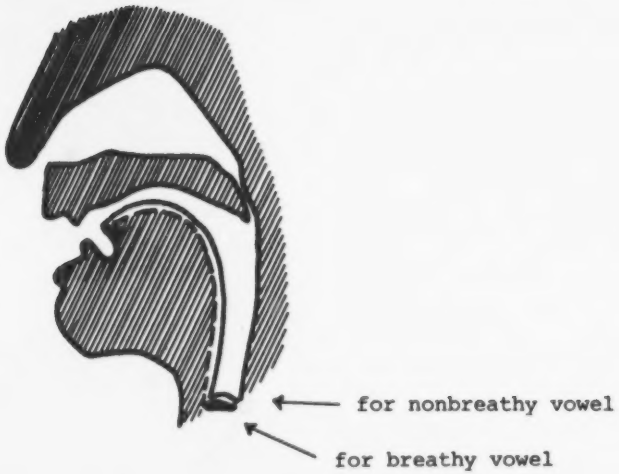


Figure 5. Relative positions of the larynx during the production of breathy and nonbreathy vowels.

In the production of breathy vowels, there is a greater muscular tension in the diaphragm resulting from the pressure required to drive the air from the lungs through the slightly open glottis to produce vibrations that could match those for nonbreathy vowels. Measurement of formant frequencies shows, however, that exact matching is not attained, because the formant frequencies for breathy vowels are lowered relative to those for nonbreathy vowels (see figs. 5 and 10).

Physiology of Breathy and Nonbreathy Vowels in Dinka. Two experiments were carried out to find out what is involved physiologically in the production of breathy and nonbreathy vowels. The first of these was carried out on the author by Dr. Steven Shaefer of the University of Texas Health Science Center, Dallas, at the Veterans Adminis-tration Hospital, Department of Otolaryngology. The following instruments were used: (a) the Hopkin's Hardtube optical system with xenon light storz source and Nikon F3 single lens reflex (SLR) camera with power driver, and (b) Olympus flexible fiber optic tube to access the pharyngeal cavity through the left nostril with Nikon F3 SLR camera with power driver and viewscope.

The procedure for the first experiment was as follows:

(1) Anesthetization of the tongue, nostrils, and pharyngeal cavity with xylocaine.
(2) Examination and photography over the tongue root using Hopkin's Hardtube.
(3) Examination through the nostril along the back wall using flexible fiber optic tube (Olympus).

Dr. Shaefer reported the following results:

(1) In modal voice there is a tendency for the ventrical fold to cover the true folds and for the epiglottis to descend upon the larynx superior.
(2) The epiglottis itself was characterized as cartilaginous and "infantile."
(3) In the breathy phonation, the ventricular folds relaxed and separated as did the vocal folds followed by slight lowering of the larynx.
(4) Due to inadequate light, the degree of opening of the vocal folds from their approximation position in modal phonation could not be defined precisely. However, Catford's (1977:99) figure of 25 to 30 percent agrees in order of magnitude with observed glottal separation, which was certainly not 100 percent, i.e., voicelessness.

The second experiment was carried out by the author, using sustained breath in the production of each vowel of the two vowel sets while the length of time to say each vowel before running out of breath was recorded. This was repeated five times for each vowel of the two-vowel sets. Jerold A. Edmondson of the University of Texas at Arlington timed the production of each vowel on the sustained breath, as shown in Table 1. Air impedance in the production of breathy vowels is concluded to be less than that for nonbreathy counterparts. The maximum duration of phonation for nonbreathy vowels is over three times as long as the duration of phonation for breathy vowels.

Table 1. Air impedance in seconds

	(i)		(e)	
	nonbreathy	breathy	nonbreathy	breathy
Time, in seconds	18.5	8.5	18.0	5.5
	18.0	8.0	18.5	7.0
	18.0	5.0	18.0	6.5
	19.0	6.0	17.5	5.5
	19.5	5.5	19.0	5.5
	----	---	----	---
Average, in seconds	18.6	6.6	18.2	6.0

	(ɛ)		(a)	
	nonbreathy	breathy	nonbreathy	breathy
Time, in seconds	18.5	4.5	17.0	5.5
	17.0	5.5	20.0	5.5
	18.0	5.5	19.5	8.5
	17.0	5.5	21.0	8.5
	17.0	4.5	20.5	5.5
	----	---	----	---
Average, in seconds	17.5	5.0	19.6	6.7

	(ɔ)		(o)	
	nonbreathy	breathy	nonbreathy	breathy
Time, in seconds	18.5	6.5	17.0	4.0
	22.0	6.0	16.5	4.5
	16.0	6.5	16.5	4.0
	20.5	7.0	14.0	4.5
	23.5	7.0	17.5	4.5
	----	---	----	---
Average, in seconds	20.1	6.6	16.3	4.3

3.2.2 Lexical-level Contrast between Breathy and Nonbreathy Vowels. The kinds of relationship between the two vowel categories are exhibited at various linguistic levels. At the lexical level the relationship is that of semantic opposition. The following examples show this opposition:

(27) /i/ vs. /ï/ riŋ 'running'
rïŋ 'meat'

cil 'growing'
cïl 'rebuking'

acuil 'kind of bushy plant'
acuïl 'kite'

liil 'to drink all of something'
lïïl 'to covet'

(28) /e/ vs. /ë/ wel 'guinea fowl'
wël 'words'

rel 'anthill'
rël 'shouting at somebody'

luet̨ 'lie'
luët̨ 'bring it with you'

teer 'argument'
tëër 'scrambling for something'

(29) /ɛ/ vs. /ɛ̈/ kɛc 'bitterness'
kɛ̈c 'biting'

riɛl 'strength'
riɛ̈l 'eel'

tɛñ 'to burst open with a sharp sound'

tɛ̈ñ 'act of frying'

yɛɛc 'selling'
yɛ̈ɛc 'carrying'

(30) /a/ vs. /ä/ man 'his mother'
män 'hatred'

maan 'to hate'
mään 'thick lip'

ŋual 'to lump up'
ŋuäl 'legendary reptile'

(31) /ɔ/ vs. /ɔ̈/ tɔŋ 'spear'
tɔ̈ŋ 'saying good-bye'

rɔk 'fence'
rɔ̈k 'fish or rat trap'

apʷɔl 'it is light'
apʷɔ̈l 'it tastes bad'

lɔɔr 'you go'
lɔ̈ɔ̈r 'dance'

(32) /o/ vs. /ö/ ror 'forest'
rör 'men'

ṭok 'mouth'
ṭök 'goats'

dol 'to roll something'
döl 'bicycle'

koot 'thorn tree'
kööt 'shields'

I have tried as much as possible to vary the environments within which the two vowel categories contrast in anticipation of doubts that may be raised as a result of limited environments of contrast.

Contrary to claims made regarding breathy /u/ (Jacobson 1980), it should be noted that /u/ does not appear with its breathy counterpart in the preceding contrasts. This asymmetry occurs because I can find no examples of contrasts at the lexical level. In the writings positing breathy /u/ I have been able to find that the counterpart of /u/ is not based on breathiness but on other factors, notably tone and length. For example, in Jacobson's writings, the words used

to contrast breathiness and nonbreathiness in connection with /u/ are:

(33) (a) kuur 'hill (breathy)'
(b) kur 'hills (nonbreathy)'

The difference between the two words is one of vowel length. The last one is a short centralized vowel and the first one is a long vowel (cf. 6.1). There is no surface breathy /u/ although there seems to be some sort of an underlying breathy /u/. At least /u/ alternates with two of the other back vowels /ɔ̈, o/ in morphological processes in the same patterns as the front vowels alternate between breathy and nonbreathy features. Consider the following:

(34) *Plurality alternations of nouns*

	Singular	*Plural*	*Gloss*
(a)	wut	wʷɔ̈t	'camp'
(b)	pul	pʷɔ̈t	'pool'
(c)	but	bʷɔ̈t	'bush'

(35) *Verb/verbal noun alternations*

	Verbal noun	*Verb*	*Gloss*
(a)	muc	moc	'to shoot'
(b)	pun	pon	'to weed'
(c)	lum	lom	'to speak behind someone's back'

Examples 34 and 35 show that /u/ alternates with one of /ɔ̈, o/ at one or another level in which there are morphological alternations taking place, but it does not alternate with /ö, ɔ/ in any morphological process. (Observe this in the pairs that follow.) The changes that take place between /u/ and /ɔ̈/ or /o/ reveal the skewing of the pattern through lack of /u/ breathy counterpart. As can be seen, /u/ alternates with /o/ when the alternation process is otherwise exclusively between breathy and nonbreathy counterparts (see example 38). When the morphophonemic process includes alternation both between a vowel and its next lower or higher neighboring vowel and between breathy and nonbreathy vowels, /u/ alternates with /ɔ̈/ (see examples 36 and 37). Thus it can be concluded from this that /ɔ̈/ represents breathy /u/ phonologically.

The behavior of the back vowels in the morphological processes is a point crucial to this discussion because an explanation is needed for the lack of surface breathy /u/ as

claimed, and for the irregularity in patterns that are regular for front vowels. It can be noticed that in some of the morphological processes, regularity in patterns breaks down in the area of the back vowels. Responsibility for this asymmetry can be assigned to lack of surface breathy /u/ (see page 52).

3.2.3 Grammatical Roles of Breathy and Nonbreathy Vowels. The next level in which we see the relation of the vowel categories is the grammatical level. The breathy/nonbreathy alternation also marks some morphological categories. It is evident from the examples given in the rest of this chapter, as well as those already given in 33-35, that breathy/nonbreathy vowels carry morphological information.

3.2.3.1 Plurality alternations of Nouns

(36)	*Singular*	*Plural*	*Gloss*
(a)	yi̱ṯ	yï̱ṯ	'well'
(b)	deŋ	dëŋ	'rain'
(c)	pɛ̱y	pɛ̈y	'month (moon)'
(d)	mac	mɛ̈c	'fire'
(e)	ŋʸal	ŋʸɔl	'knee'
(f)	rɔk	rak	'fence'
(g)	loñ	lʷɔ̈ñ	'any member of the cat family'
(h)	wut	wʷɔ̈t	'camp'

The examples in 36 evidence a certain regularity that suggests a rule. Note, however, that the pattern is not perfectly congruent. Front vowels, realized as [i, e, ɛ], become breathy, i.e., [ï, ë, ɛ̈], in plurals (cf. 36a, b, c), for which I write the following rule:

$$V \rightarrow [+\text{breathy}] \; / \; \overline{[\text{plural}]}$$

However, the vowels realized as [a, ɔ, o, u] are not turned into their breathy counterparts, i.e., [ä, ɔ̈, ö, ü], for plurality. A schematic representation of the observed alternations is given in figure 6.

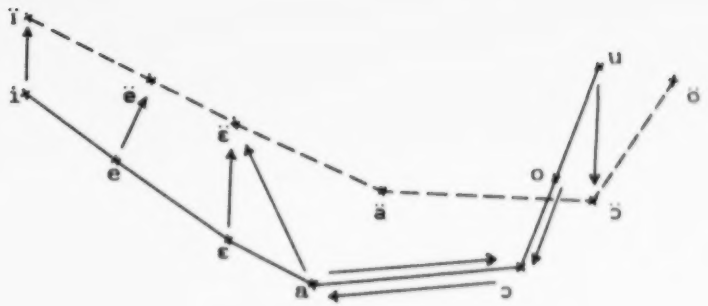


Figure 6. Plurality alternations of nouns
(The category connected with broken lines is the breathy category. The arrows show the direction of change from singular to plural.)

In other words, while the back vowels make use of vocal alternation to mark plurality, this alternation is not simply between nonbreathy and breathy counterparts, as in the front vowels, but rather between neighboring vowels, for example:

a <---> ë/ɔ
o <---> ʷɔ
u <---> ʷɔ̈

As can be seen, vowel height and sometimes labialization or palatalization epenthesis are also involved. The alternations o <---> ʷɔ and u <---> ʷɔ̈ may establish a second pattern of lowering the singular vowel one level in height, i.e.; /ɔ/ is one level lower than /u/. The [ʷV, ʸV] are simply the usual rule of labialization and palatalization respectively. This rule would be written as

$$\begin{bmatrix} V \\ n \text{ high} \end{bmatrix} \text{<---} [+\text{ cons}] \begin{bmatrix} V \\ n\text{-}1 \text{ high} \end{bmatrix} [+ \overline{\text{plural}}]$$

In other words, there is epenthesis of homorganic labial or palatal features and the following vowel is lowered one degree of height (cf. 36g and h).

However, note that /a/ can become ɔ or ɛ̈, i. e., there is raising of vowel height one degree and the breathy or nonbreathy property is lexically determined. Thus we have

$$\begin{bmatrix} V \\ n\ high \end{bmatrix} \langle\text{---}\rangle \quad [-\ voc] \begin{bmatrix} V \\ n\text{-}1\ high \end{bmatrix} \quad [+\ \underline{\quad\quad}\ plural]$$

While the lack of a simple rule for plurality marking may be somewhat disturbing, a fact that makes the situation still more complex is that Dinka plurality does not even obey Mayerthaler's (1980) principle of *constructional iconicity* (i.e., constructional resemblance).

Table 2: Some plurality alternations of nouns

Singular		*Plural*
i	--->	ɪ̈
e	--->	ë
ɛ	--->	ɛ̈
a	<--->	ë
		ɔ̈
ɔ	--->	a
o	--->	ɔ
u	--->	ɔ̈

The alternations in table 2 are not all that is involved in the Dinka singular/plural issue. Some phonologists—those Welmers (1973) characterizes as prepared to posit distinctive features comparable to moves on a game board—might see chances of capturing such alternations in a rule. But it is doubtful that a single, neat rule could be developed to include both examples 36 and 37.

(37)	*Singular*	*Plural*	*Gloss*
(a)	tik	dʸär	'woman'
(b)	cil	cʸèl	'rhinoceros'
(c)	tim	tiim	'tree'
(d)	weŋ	yɔ̈k	'cow'
(e)	met	mït	'child'
(f)	leet	lɛt	'onionlike plant'
(g)	rɛɛt	rët	'razor'
(h)	ayʸɛl	ayil	'chaff'

(i)	rʸɛm	rim	'blood'
(j)	abɛ̈ɛ̈l	abɛ̈l	'fool'
(k)	ñaŋ	ñʸeŋ	'crocodile'
(l)	añaar	añʸɛr	'buffalo'
(m)	kʷac	kʷäc	'leopard'
(n)	kɔɔr	kar	'elbow'
(o)	rɔu	röt̠	'hippopotamus'
(p)	rɔk	rak	'fish or rat trap'
(q)	rol	rut	'barren'
(r)	ŋom	ŋïïm	'head'
(s)	rol	rɔt	'throat'
(t)	wum	wuum	'nose'
(u)	rut	rʷɔt	'autumn'
(v)	pul	pʷɔt	'pool'
(w)	jöt̠	jot̠	'necklace'

The difficulty with the pairs in 37 is that there are, for example, cases of vowel shortening (37f and g), vowel lengthening (37c), vowel raising (37e), vowel lowering (37u), and tone change (37w). There are also cases of *strong suppletion* (37a and d). These alternations only confirm the conclusion Welmers (1973) reached about Dinka alternations, that is, that it is impossible to capture the alternations with a single rule. Both the patterned alternations suggest a phonological rule to capture the generalization. Data as in example 37, however, preclude any possibility that an exhaustive account of Dinka plural morphology could be expressed as a single rule. Still, the number of pluralization strategies in Dinka is disconcerting.

3.2.3.2 Verb/verbal Noun Alternations. Besides the singular/plural dimension, there are verb/verbal noun alternations that present regular patterns over a very wide range of items.

(38)

	Verb	*Verbal noun*	*Gloss*
(a)	lim	lïm	'to beg'
(b)	cil	cïl	'to rebuke'
(c)	nin	nïn	'to sleep'
(d)	yʷit	yʷït	'to knock down'
(e)	tem	tëm	'to cut sorghum'
(f)	dek	dëk	'to drink'
(g)	t̠el	t̠ël	'to pull'
(h)	rʸɛc	rʸëc	'to dodge'
(i)	cam	cäm	'to eat'
(j)	cat̠	cät̠	'to walk'

(k)	raak	räk	'to milk'
(l)	lɔc	löc	'to choose'
(m)	rɔk	rök	'to fence'
(n)	rɔm	röm	'to share'
(o)	jɔt	jöt	'to lift'
(p)	tɔk	tök	'to divide food'
(q)	ñop	ñup	'to burn'
(r)	cop	cup	'to chase'
(s)	moc	muc	'to shoot'
(t)	lom	lum	'to speak behind someone's back' [1]

From these examples one can say that to change a verb to a noun, the nonbreathy vowel in the verb becomes breathy except for /o/ which becomes /u/. However, alternations like the following make an otherwise simple analysis problematic.

(39)

	Verb	*Verbal noun*	*Gloss*
(a)	lʷɛk	lʷek	'to shake'
(b)	mak	mɛ̈c	'to tether'
(c)	yar	yɛ̈r	'to split'
(d)	kʷal	kʷël	'to steal'
(e)	raak	räk	'to milk'
(f)	tooc	tʷɔ̈c	'to sand'
(g)	puur	pʷɔ̈r	'to cultivate'
(h)	lʷeel	lʷɛl	'to say'
(i)	leec	lɛc	'to praise'
(j)	rɛɛc	reec	'to reject'
(k)	kʷaaţ	kwɛ̈ţ	'to drive (cows or goats)'

One thing is very clear--the verbs in this group do not contain a systemic breathy/nonbreathy contrast. This is not to say no rule exists. In other words, it is possible for the investigator to state that verbal noun formation is effected either by change from nonbreathy to breathy vowel or by change to the next higher or lower nonbreathy vowel.

However, from the examples we have seen, and others to be presented from other areas of grammar, the change from nonbreathy to breathy in the formation of nouns is more productive than other processes.

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1 Dinka Rek will reduplicate a lot of these verbal nouns, but without effect on their present vowels.

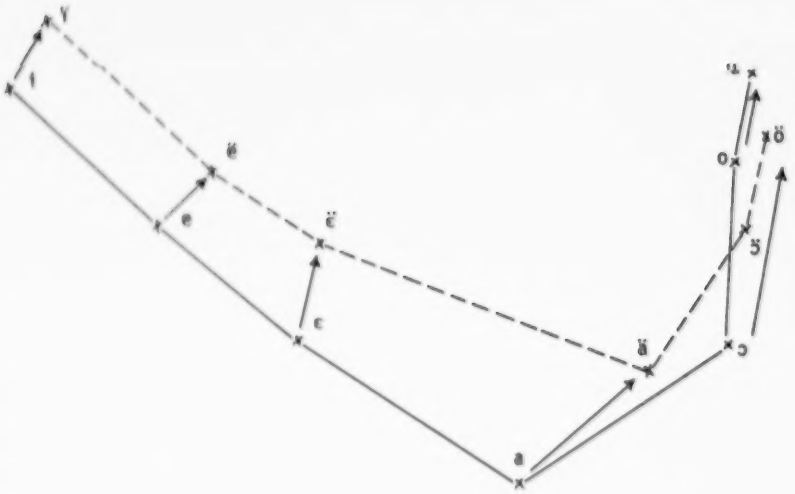

Fig 7. Verb/verbal noun alternations

3.2.3.3 Transitive Verbs without Objects. In Dinka, transitive verbs enter into *objectless construction* through vocalic alternations. As noted above, most verbs, if not all, have a base form with nonbreathy vowels. Whenever a transitive verb appears in a sentence without a specified object, this change is signaled by a change of vowel as can be observed in the following:

(40) (a) aŋäŋ alim miŋ
poor is-beg deaf
'The poor man is begging from the deaf person.'

aŋäŋ alïm
poor is-begging
'The poor man is begging.'

(b) run apiṯ tap
person is-transplanting tobacco
'The person is transplanting tobacco.'

run apïɻ
person is-transplanting
'The person is transplanting.'

(c) tik atit meɻ
woman is-waiting child
'The woman is waiting for the child.'

tik atït
woman is-waiting
'The woman is waiting.'

(d) ɻɔk adek piw
goat is-drinking water
'The goat is drinking water.'

ɻɔk adɛk
goat is-drinking
'The goat is drinking.'

(e) tik atet lʸɛɛm
woman is-picking vegetables
'The woman is picking vegetables.'

tik atët
woman is-picking
'The woman is picking.'

(f) ña arak weŋ
girl is-milking cow
'The girl is milking the cow.'

ña arɔk
girl is-milking
'The girl is milking.'

(g) ɖɔk acam kʷïn
boy is-eating food
'The boy is eating food.'

ɖɔk acʸɛ̈m
boy is-eating
'The boy is eating.'

(h) ña alɔk alaɻ
girl is-washing clothes
'The girl is washing clothes.'

ña alɔ̈k
girl is-washing
'The girl is washing.'

(i) meṯ alɔc lëc
child is-choosing stick
'The child is choosing a stick.'

meṯ alöc
child is-choosing
'The child is choosing.'

(j) ḏök aloñ ṯök
boy is-releasing goats
'The boy is releasing goats.'

ḏök aluñ
boy is-releasing
'The boy is releasing.'

(k) tik apon tɔŋpiñ
woman is-weeding peanuts
'The woman is weeding peanuts.

tik apun
woman is-weeding
'The woman is weeding.'

The alternations here show that change from object-retaining transitive verb to non-object-retaining transitive verb is also a productive process, if productive means that a native speaker will make a non-object-carrying transitive verb from an object-carrying transitive one by applying the nonbreathy/breathy alternation.

3.2.3.4 Possessive Formation. Another area showing alternation is *possessive formation*. These changes, unlike what we have witnessed so far, are between members of each vowel category (breathy or nonbreathy), i.e., between a vowel and its next higher or lower neighbor and member of the same vowel category:

(41)

	Possessive formation		
	Free form	*Possessive*	*Gloss*
(a)	moc	mʷɔñde	'her husband
(b)	löṯ	lɔ̈ŋden	'their bell'
(c)	pur	pʷɔ̈rde	'his hoe'
(d)	tik	tʸɛŋde	'his wife'
(e)	ñïr	ñʸɛ̈rken	'their daughters'
(f)	lek	lɛŋde	'her pestle'
(g)	cök	cɔ̈kken	'their feet'
(h)	kɔc	kackʷa	'our people'

(i)	lɔ̈m	lämken	'their ribs'
(j)	agʷek	agʷɛŋde	'its frog'
(k)	lek	lɛkkʷa	'our kind of fish'
(l)	ɫɔ̈k	ɫäkke	'his goat'
(m)	lec	lɛcke	'her teeth'
(n)	rɛc	räcdʸɛ̈	'my fish'
(o)	ror	rʷɔrden	'their forest'
(p)	til	tʸɛldu	'thistle'
(q)	weŋ	wɛŋde	'his cow'
(r)	lek	lɛŋde	'her pestle'
(s)	gʷɛ̈t	gʷɛ̈nde	'her bead'
(t)	yɔ̈k	yäkken	'their cows'
(u)	meɫ	mɛŋde	'his child'
(v)	yɔ̈t	yɔ̈nde	'his house'
(w)	tim	tʸɛmden	'their tree'
(x)	amuc	amʷɔñden	'his milk container'
(y)	wum	wʷɔmde	'his nose'
(z)	ñin	ñʸɛnde	'his eye'
(aa)	leŋ	lɛŋde	'his drum'
(bb)	biɫ	bʸɛŋde	'his fishing spear' [2]

In order to formulate a morphophonological rule, I can employ the feature system of Chomsky and Halle (1968) with only one alternation, namely the feature [high]. I am assuming Dinka has the following phonological vowel heights (repetition of symbols in fig. 8 is explained following the figure):

	nonbreathy		breathy	
5	i	u	ï	
4	ɛ	ɔ	ɛ̈	
3	e	o	ë	ö
2	ɛ	ɔ	ɛ̈	ɔ̈
1	a		ä	

Figure 8. Vowel heights.

As the examples in 41 show, the nouns in the possessive forms have a vowel nucleus one degree lower than that in the nouns in their free forms. Therefore, I use the feature

2 With the present trend of development in literacy, these possessive forms will be the standard ones in Dinka because they are the ones used by dialects which are candidates for becoming the base of standard Dinka.

[high] as a dimension with five values on it: 5 = i, ï, u; 4 = ɛ, ɛ̈, ɔ̈; 3 = e, ë, o, ö; 2 = ɛ, ɛ̈, ɔ, ɔ̈; and 1 = a, ä. Accepting for the moment the peculiarity of having ɛ, ɛ̈, and ɔ̈ both higher and lower than e, we may now state the rule of possessive formation very neatly as:

$$\begin{bmatrix} V \\ n\ high \end{bmatrix} \quad \text{---}> \quad \begin{bmatrix} [-\ vocalic] \\ n \geq 3 \end{bmatrix} \begin{bmatrix} V \\ n-1\ high \end{bmatrix}$$

A vowel breaks into two parts: a labialization feature (e.g., 41c, x, and y) or a palatalization feature (e.g., 41w, z, and bb), and a vowel lowered by one level of height:

nonbreathy		breathy	
i	u	ï	
ɛ	ɔ̈	ɛ̈	
e	o	ë	ö
ɛ	ɔ	ɛ̈	ɔ̈
a		a	

Fig. 9. Possessive noun alternations

There remain, however, some anomalies with this solution that I am still unable to resolve. For n = 4, there are rarely or never changes from ɛ/ɔ̈ to e/o or from ɛ̈ to ë. At present, time and space prevent me from pursuing the matter further here. Still, it is clear that some process is at work similar to what I have proposed.

Some of the other phonological processes are usually not easily noticed because they take place across word boundaries. One such process is assimilation, which can be seen taking place between the syllables of the possessed and the possessor in a compound word. This process is generally productive, although certain consonants appear not to have undergone assimilation in the preceding list. Example 41n shows /rɛ̈c/ ---> /räcdʸɛ̈/ leaving unassimilated /c/, which should be assimilated to /d/ as in 41a /moc/ ---> /mʷɔ̃de/. The assimilation that occurs has no surface representation because the voiced sound that should predominate is one of the voiced stops (i.e., [dz] which is never used syllable or

word finally (see fig. 1). Further discussion of the phenomenon is outside our area of concern since it is a process among the consonants.

3.2.3.5 Vowel Harmony. Some previous linguistic analyses have proposed a vowel harmony theory to explain breathy vowels in Dinka (see sect. 2.1.3). However, most Dinka words are monosyllabic, and the few that are polysyllabic do not manifest these rules.

Some would say that morphology is responsible for this failure. According to B. L. Hall et al. (1974), the forms connected with vowel harmony are the *dominant*, the *recessive*, and the *opaque* forms. The dominant form [+ATR] (the breathy type) causes contiguous recessive forms [-ATR] (the nonbreathy type) to shift harmonic series and become [+ATR]. Opaque forms are those with [-ATR] vowels which do not shift harmonic class when contiguous to a dominant form. If the preceding is what is meant by vowel harmony rules, then Dinka complies with them. Yet, this does not rule out the distinctive role played by the breathy vowels in Dinka.

The following are some phonological words which cast doubt on the application of vowel harmony in Dinka:

(42)	(a)	mëtil	'the jealous'
	(b)	mëkok	'the greedy'
	(c)	mëneñ	'the hot tempered'
	(d)	mëcʷiŋ	'thrifty person'
	(e)	adök	'gum'
	(f)	macär	'black bull'
	(g)	makɔ̈y	'red bull with a white patch on the side'
	(h)	ñingääw	'name (companion)'
	(i)	akërac	'name'
	(j)	ñïcol	'name'

From these examples, it is clear that /i, e, a, o/ are all opaque. They occur here contiguous to [+ATR] vowels, but they do not change harmonic series. At this point, the application of vowel harmony in Dinka seems doubtful. It is not vowel harmony that is responsible for the presence of breathiness in Dinka, as some writings seem to suggest for other Nilotic languages. If breathiness developed in Dinka solely for vowel harmony purposes, it is now present mostly for distinctive purposes.

4 ACOUSTIC CHARACTERISTICS OF BREATHY AND NONBREATHY VOWELS.

To determine the acoustic relationship between breathy and nonbreathy vowels, a recording of pairs of words was made. Six contrastive pairs and a single word were analyzed on the Kay Elemetric Sonagraph. They were produced by different native speakers articulating them as they would in normal speech.

Only a small number of sonagrams of one person are used here, those of a thirty-year-old male speaker. Refer to table 3 for a list of these pairs and the F_1 *(first formant frequency)* and F_2 *(second formant frequency)* values in hertz for the vowels in the corresponding words. (See the Appendix for those of other speakers.) Looking initially at data from only one speaker proves useful in recognizing the differences between the two vowel categories.

TABLE 3. First and second formant frequencies (in hertz) for Dinka Vowels

F_1	*F_2*	*Word*	*Gloss*
185	1835	riŋ	'running'
125	1750	rïŋ	'meat'
310	1620	wel	'guinea fowl'
250	1500	wël	'words'
375	1435	rɛc	'spoiling'
310	1370	rɛ̈c	'fish'
500	1060	man	'his mother'
400	900	män	'hatred'
375	750	tɔŋ	'spear'
310	625	tɔ̈ŋ	'bidding good-bye'
250	625	ṭok	'mouth'

240	490	ţök	'goats'
210	625	ŋut	'camp'

The formant data from the recordings of the pairs in table 3 were then used in making a plot of the vowels according to the procedure in Ladefoged (1975:172). The first formant is plotted vertically on a linear scale against the difference between the second and first plotted horizontally on a logarithmic scale. Such a display, with the frequency of the first formant increasing downward along the Y-axis and that of the second formant increasing to the left along the X-axis, is plotted in this fashion because it looks very much like the traditional vowel quadrangle. This relationship between the two vowel categories is depicted in figure 10.

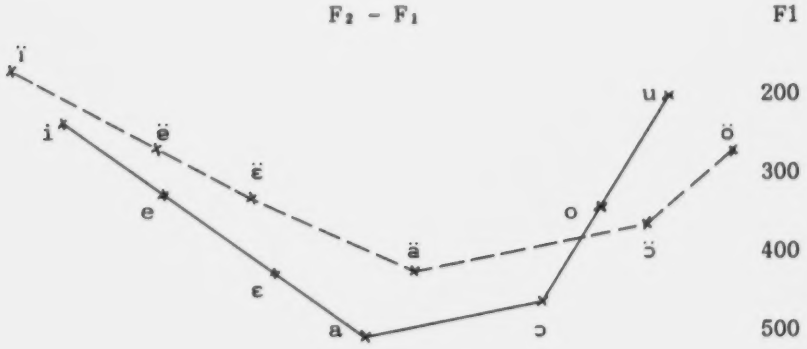

Figure 10. Frequencies of first two formants of breathy and nonbreathy vowels

As figure 10 clearly shows, one vowel category is higher--i.e., has a lower F_1 value than the other. The higher category, connected by broken lines, is the breathy vowel category; the lower one, connected by solid lines, the nonbreathy category. This pattern is in line with how these vowel categories react in the vowel harmony of Robert M. Vago (1980:184) and also Laver (1980:115d). The relationship between the breathy and the nonbreathy categories can be characterized as follows: The breathy vowels appear more back and higher in the diagram than their counterpart nonbreathy vowels; that is, the frequency of F_1 and the

difference in frequency between F_2 and F_1 are lower for breathy vowels than for nonbreathy vowels.

The lower F_1 of the breathy vowels is due to the fact that, in the production of breathy vowels, as described in the preceding chapter, there is enlargement or dilation of the vocal tract. This enlargement lowers the formant frequencies, just as larger organ pipes have lower resonant frequencies. In other words, the first and second formant frequencies are lowered, and this results in the following: (a) lowering of the first formant frequency, which gives rise to "height" in vowel position, and (b) lowering of the second formant frequency enough to lessen the difference between the two formant frequencies ($F_2 - F_1$), giving rise to the relative "backness" of the breathy vowels (see table 3). Lowering of the formant frequencies, as a result of the lowering of the larynx, giving rise to a long vocal tract, is in line with the fact that sounds produced with relative long resonating cavities have lower formant frequencies (Lieberman 1977:45).

My claim that there is a dilation of the vocal tract in the production of breathy vowels is not difficult to verify. It depends simply on finding out if there is a loss of high frequency energy. Such loss is indicative of dilation of the vocal tract; when the pharynx is dilated, the lax pharyngeal wall absorbs the high frequency energy (Jacobson 1980:186). In the sonagrams this loss in high frequency energy is seen as lightness of high formant frequencies. In our case it is easy to demonstrate this alternation as there are two vowels to compare. Figures 11-17 show that the high frequency tracings for the breathy vowels are lighter than those for the nonbreathy vowels (Laver 1980). The loss of high frequency energy may be a part of the cause for the "muffled" impression as opposed to "brassy" for the ones without loss of energy at the high frequency level.

All in all, the difference between the two vowel categories is due partly to dilation of the vocal tract and partly to a difference of phonation. The dilation is brought about by the adjustment of pharyngeal muscles and results in a slight aperture in the vocal folds and slight lowering of the larynx, thereby affecting phonation. Therefore I am forced to conclude that the advanced or retracted tongue root position which the vowel harmony approach claims as responsible for the difference between the two vowel categories is not adequate. However, Ladefoged's (Lindau,

Jacobson, and Ladefoged 1972) pharyngeal width approach is compatible with the results obtained in this study.

From the sonograms for the two vowel categories, it can be seen that the vowels are more closely spaced in the back than in the front. That is, the acoustic space is smaller in back than in front, as is the anatomical space. That the back vowels are crowded into a smaller area may be the reason we do not have the /u/ breathy counterpart.

Another observation that can be made about the back vowels in Dinka is that they do not have as systematic a pattern of positional occurrence on the chart as do the front vowels. This may be responsible for the inconsistency they exhibit as opposed to the consistency of the front vowels in various morphological processes (see ch. 3).

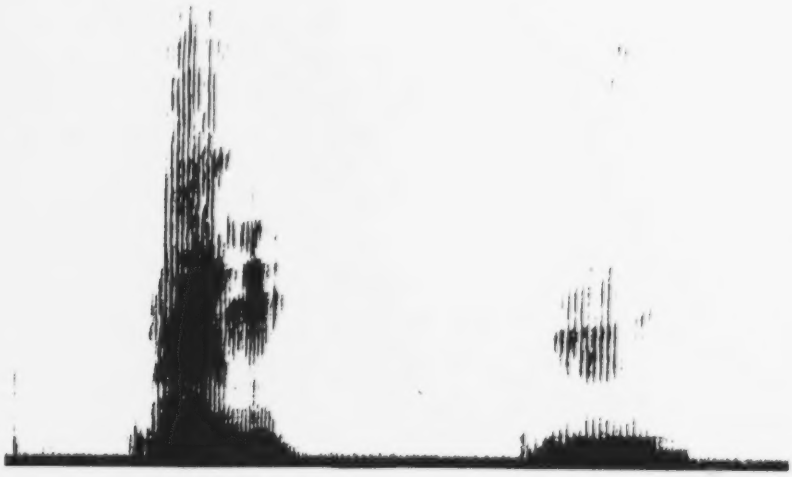

Figure 11.

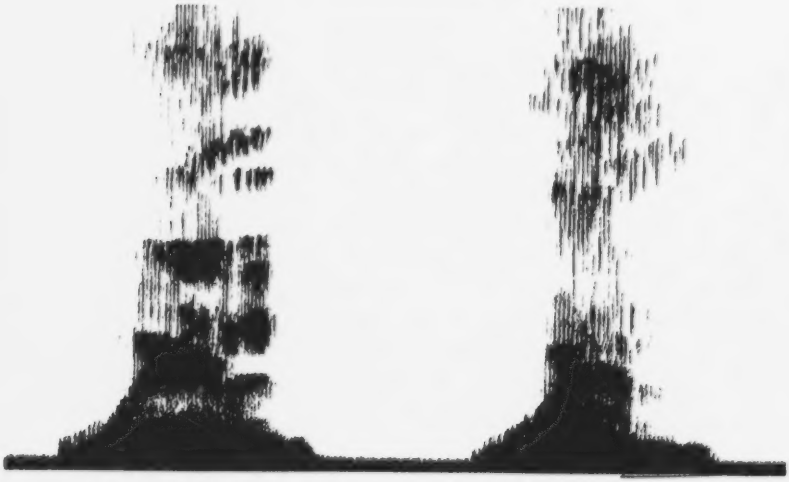

Figure 12.

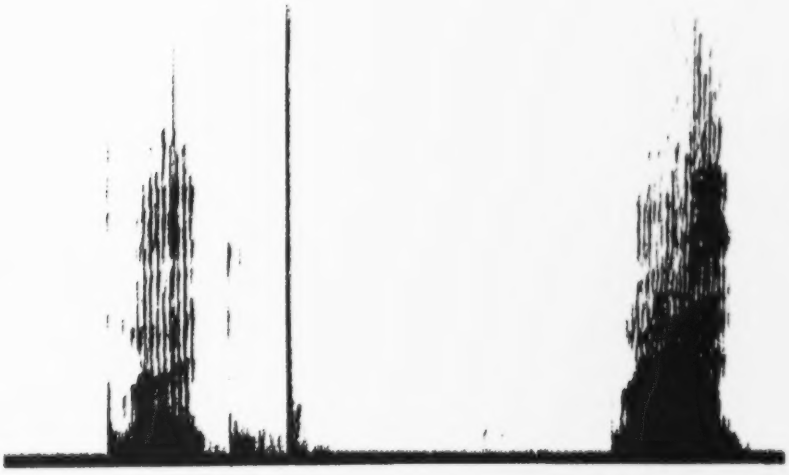

Figure 13.

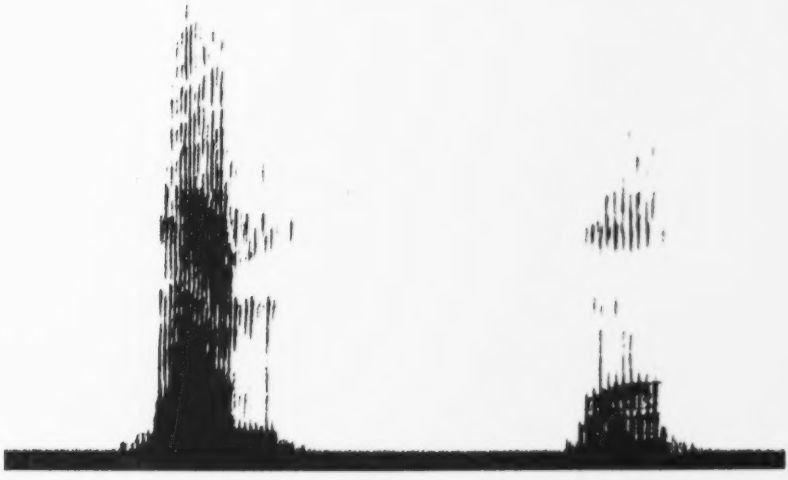

Figure 14.

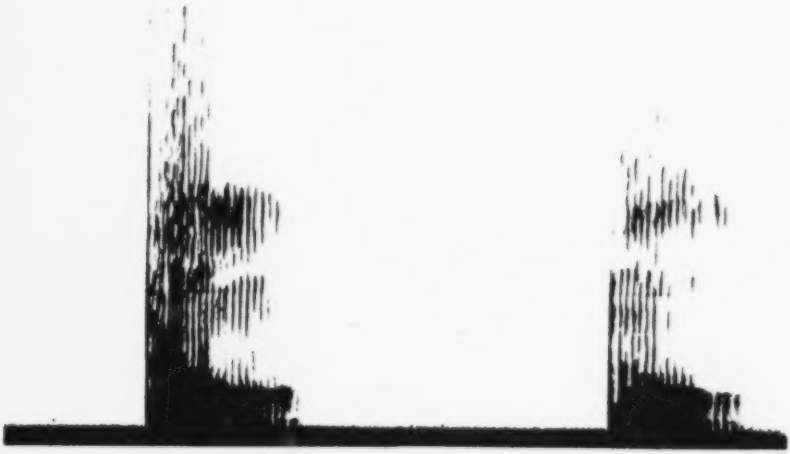

Figure 15.

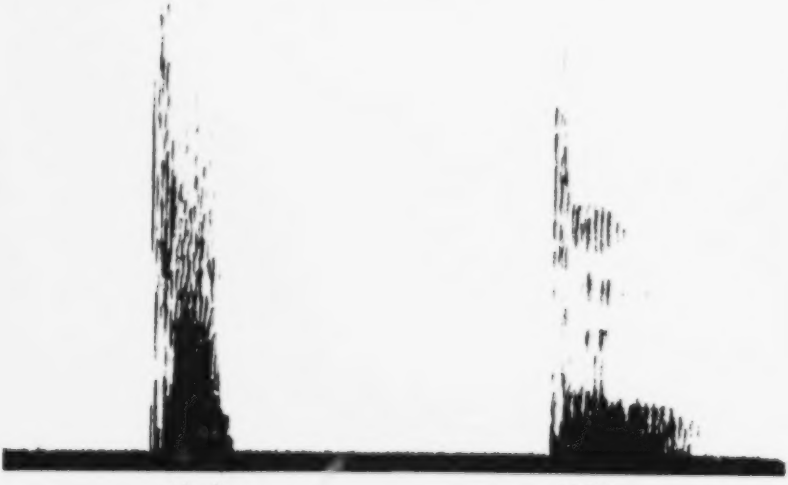

Figure 16.

Figure 17.

5 TONE

5.1 Tone Background

The word *tone* has many meanings. Among them are:

(a) accent or inflection expressive of mood or emotion;
(b) the pitch of a word often used to express differences in meaning;
(c) a particular pitch or change of pitch constituting an element in the intonation of a phrase or sentence (Webster's New Collegiate Dictionary 1981).

None of these definitions, however, seems adequate to describe tone in its many linguistic manifestations.

All languages in the world share tonality to some extent as a part of their total description. However, there are some languages that are called *tone languages* by linguists. The difference rests, according to Kenneth L. Pike (1948:3-7) on a language having lexically significant, contrastive but relative, pitch on each syllable--an observation that he attributes to Beach (1924). In English, differences may be signaled by pitch, but such meaning difference is applied to a phrase as a whole or to affective differences (emotional coloring) of words. When I use the term *tone* and *tone languages* here I refer to the use of pitch to distinguish the *meaning* (not the importance) of individual lexical items.

Tone languages are not identical in the types of tone contrasts they utilize. It is generally recognized (Pike 1948) that there are two principal types of tone languages: *contour* tone languages and *register* tone languages. Contour tone languages are spoken primarily in Asia, and include Chinese, Burmese, Thai, and Vietnamese. These languages

have linguistically significant pitch differences over the duration of a syllable, e.g., long, short, gradual, abrupt, rising, falling, rising and falling, and falling and rising. Also, the initial and final points of such glides cannot be described as being fixed.

Register tone languages are spoken in Africa and in the Western Hemisphere. These languages have tones whose contrast lies in level differences, usually two, three, or four; they can have all the possible types of glides between the fixed levels. One way to think of register tone languages is to equate the levels to stairsteps with glides extending from one step to another.

The following data from Thai illustrate contour tones (Ladefoged 1975:228):

(43)

Tone No.	*Description*	*Pitch*	*Tone Letter*	*Example*	*Gloss*
1	low falling	21		naa^{1}	'nickname'
2	high falling	51		naa^{2}	'face'
3	high rising	45		naa^{3}	'aunt'
4	low falling rising	215		naa^{4}	'thick'
5	common mid falling	32		naa	'field'

Each tone is assigned a number, a description, a sequence of digits indicating the pitch pattern, a tone letter to describe its contour and a representation as a series of segments plus a superscript number (with 5 left unmarked).

The following data from Nupe illustrate register tones (Fromkin and Rodman 1978:87):

(44)

Tone	*Symbol*	*Example*	*Gloss*
high tone	[‾‾]	bá	'to be sour'
mid tone	[—]	bā	'to cut'
low tone	[_]	bà	'to count'

Each tone is assigned a description and a tone symbol for its contour and representation as a series of segments plus an accent mark.

Having discussed and exemplified tone generally, I now turn to questions of whether Dinka is a tone language, and if it is, what kind of tone language, how many tones it has, and at what level the tones operate.

5.2 Tone in Dinka

Linguistic studies of Dinka have heretofore not said much about tone. Tucker's (1948:19) only comment was, "Intonation is present to a high degree.... Semantically, ... tonal doublets are not very common." More recently Duerksen and Agany (1982) identify three tones, high (´), medium (-), and low (`), and give examples to illustrate their claim. They say, for instance, that lengthened vowels may have falling or rising tone patterns. They describe the production of tone as follows:

> The tone is produced by either raising the larynx for high tone or lowering the larynx for low tone. The raised larynx decreases the length of the vocal tract (pharynx) thus raising the pitch of the sound. The lowered larynx increases the length of the vocal tract thus lowering the pitch. These differences may be felt by placing the fingers on the larynx (Adam's apple) and feeling it moving up for high tone and down for low tone. (Duerksen and Agany 1982:2)

Duerksen and Agany's work on tone is the first of its kind on Dinka. Because I was uncertain how they arrived at three tones, I felt it was necessary here to make further investigations, carried out not on the basis of the height of the larynx, which has an insignificant effect on pitch compared to vocal fold tension, but on the basis of linguistic data.

In collecting data for this analysis I have examined over two hundred lexical items. Each of the thirteen vowels--six breathy and seven nonbreathy--was taken as the nucleus of at least fifteen words. As a native speaker of Dinka, I produced each item in the presence of Eunice Pike, so she could use her considerable phonological expertise in helping find tone contrast. Various frames were made to find the

tone clusters, but this aspect was not pursued inasmuch as the purpose here is not the analysis of tone in its own right, but only in relation to the vowels.

In order to confirm the results from the subjective analysis of the linguist s ear, candidate lexical items were analyzed by means of a P/M Pitch Analyzer, an acoustic device that measures fundamental frequency in hertz, and intensity in decibels. As Gandour (1978) and Ohala (1978) have shown, *tone* (the linguistic name) and *pitch* (the perceptual unit) correlate acoustically with the fundamental frequency (F_0) of the complex periodic sound waves generated by the vocal folds.

Customarily, to prove that a language is a tone language there must be two kinds of evidence: (a) pairs or groups of contrasting lexical items that differ solely by pitch, and (b) the unconditioned patterns of contrastive pitches. Using contrasting word groups and the Pitch Analyzer I found three phonemic tones. Consider the following triplets and doublets of items with the tones I have now assigned:

(45)	(a)	wàr	'shoes'
	(b)	wār	'shoe'
	(c)	wár	'change (command)'
(46)	(a)	lèk	'pestle'
	(b)	lēk	'kind of fish'
	(c)	lék	'to confess
(47)	(a)	yìṯ	'well'
	(b)	yīṯ	'climbing'
	(c)	yíṯ	'facts'
(48)	(a)	lʷèṯ	'lie'
	(b)	lʷéṯ	'lies'
(49)	(a)	tìk	'cut to pieces (command)'
	(b)	tīk	'woman'

Confirmation of the unconditioned patterns of contrastive pitch is found in examples 51-53. These sentences show that pitch (i.e. tone), constitutes the contrasting element in context.

(50) (a) ācì jàm yán cíl
past-he said that rhinoceros
'He said, "Rhinoceros."'

(b) ācì jàm yán cìl
past-he said that rebuke-him
'He said, "Rebuke him."'

(c) ācì jàm yán cīl
past-he said that growing
'He said, "Growing."'

While example 50 demonstrates the fact that Dinka is a tone language, the type of tone language and the nature of the tone remains to be shown. With that in mind I compared the following pairs of sentences:

(51) (a) wár ālàt̠
change cloth
'Change the cloth.'

(b) wàr ālát̠
change clothes
'Change the clothes.'

(52) (a) âbá yáäc yén tön̈
future-you carry it pot
'You will carry the pot.'

(b) ābà yàac yén tön̈
future-I carry it pot
'I will carry the pot.'

(53) (a) ācá cám yén kʷïn
perfect-you eat it food
'You have eaten the food.'

(b) ācà càm yén k ʷïn
perfect-I eat it food
'I have eaten the food.'

Examples 51-53 indicate three contrastive tones on two-syllable items *alaṯ*, *aba*, and *aca*. The three contrastive tones are designated high [´], mid [-], and low [`]. All the data from the Pitch Analyzer have shown that tone is level in Dinka. In effect this is proof that Dinka is a register tone language. The patterns of contour for this language were traced on plastic sheets directly from the face of the VII (Voice Identification Inc.) Pitch Analyzer CRT.

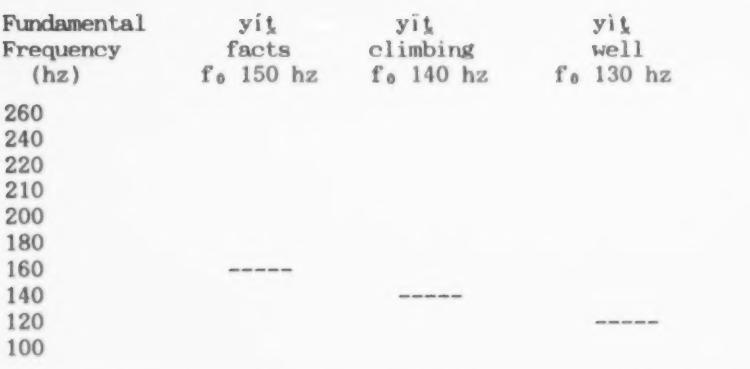

Figure 18. Patterns of contour tracings from the face of the Pitch Analyzer CRT

5.3 Vowel Distribution in Relation to Tone

It has been found that all the vowels occur with the three tones. The following is the sample from the collection of data that was analyzed for tone in Dinka:

(54) High

	Word	*Gloss*
(a)	yiṭ	'facts'
	pïw	'water'
(b)	leŋ	'drum'
	lëk	'informing'
(c)	lɛṭ	'shivering'
	pël	'letting something go'
(d)	pam	'clapping'
	bäl	'foolishness'
(e)	gɔl	'family'
	tɔ̈ŋ	'insulting'
(f)	ton	'eggs'
	töc	'massaging'
(g)	wut	'camp'

(55) Mid

	Word	*Gloss*
(a)	yiṯ	'climbing'
	lïm	'begging'
(b)	lek	'kind of fish (sg)'
	lëk	'kind of fish (pl)'
(c)	lɛṯ	'onionlike plant'
	gɛ́m	'reception'
(d)	war	'shoe'
	ŋäñ	'chameleon'
(e)	rɔu	'hippopotamus'
	kɔ̈m	'insect'
(f)	dol	'rolling of something'
	ḏöl	'way'
(g)	dum	'farms'

(56) Low

	Word	*Gloss*
(a)	yiṯ	'well'
	dïk	'sewing'
(b)	lek	'confess (command)'
	lëk	'throw at it'
(c)	rɛc	'spoiling'
	rɛ̈c	'fish'
(d)	man	'his mother'
	män	'hatred'
(e)	dɔm	'catch it'
	rɔ̈ṯ	'armpit'
(f)	dol	'has rolled'
	dök	'turning off'
(g)	kur	'dove'

Whenever a lexical item is put into context, its tones can undergo changes (*tone sandhi*) induced by the environment. However, examples will not be given here since this is not an exhaustive treatment of Dinka tones.

5.4 Tone Functions

In Dinka, tones (pitch contrasts) are employed not only to distinguish lexical items, but also to indicate a major modulatory contrast in morphology. For instance, tone is important in differentiating first person singular from second person singular. The high tone [ˊ] signals second person singular while mid tone [-] signals first person singular. This tone contrast occurs on the auxiliary verbs. The following illustrates this feature:

(57) (a) ābà ṭől bá lá béy
fut-I finish fut-you go home
'I will finish it so that you go home.'

(b) ābà ṭől bā là béy
fut-I finish fut-I go home
'I will finish it so that I go home.'

(58) (a) bá lá cám
fut-you go eat
'Will you go to eat?'

(b) bà lā cám
fut-I go eat
'Will I go to eat?'

(59) (a) cá lá béy
perf-you go home
'Have you gone home?'

(b) cà lā béy
perf-I go home
'Have I gone home?'

Tones also have a purely syntactic function. For instance, tone plays a very important role in differentiating negation from auxiliary *ācì*

(60) (a) yén ācí lá
he is-not go
'He is not going.'

(b) yén ācì là
he has go
'He has gone.'

Moreover, it differentiates active voice from passive voice:

(61) (a) yɛ́n ācì Deŋ mʷöötᵢ
I have Deng greet
'I have greeted Deng.'

(b) yɛ́n ācí Deŋ mʷöötᵢ
I have-been Deng greet
'I have been greeted by Deng.'

As can be seen from examples 57-61, tone contrasts bear an important functional load. Nevertheless, it has not heretofore been marked in the orthography. Whatever the reason for this omission, tone needs to be indicated, and one must question lexicologists who have failed to take account of it.

The way in which the tones are produced is as follows: for high tones the vocal folds are stretched, with an increase of airflow from the lungs; they are in normal position for mid tones; and for low tones the folds are relaxed. As can be seen in the tracings from the face of the Pitch Analyzer, the difference between the high and the mid tones, and between the mid and the low tones, is in absolute terms very small. The difference between the high and the low tones is easily distinguished, while the difference between mid and high or low is, at times, minimal. This may be the reason in many cases why only tones high and low are easily distinguished by analysts, while mid tone is mistakenly heard as either low or high. (Contrast Duerksen and Agany's explanation as cited in section 5.2.)

6 VOWEL LENGTH

Vowel length represents an area where very little work, if any, has been done. Tucker (1948) makes mention of vowel length in connection with word inflection by internal changes, i.e., nouns show plural and verbs show voice (what he calls *species*) by change in vowel length. Current work by Duerksen and Agany (1982) with regard to vowel length has concluded that Dinka has seven contrastive vowel positions and that vowel length is distinctive:

> Each of these seven vowels can be either *short* or *long*. Short vowels are marked using the symbol (V) and long vowels are marked using two symbols (VV).

	Short		*Long*	
(a)	adet	'cork wood (pl)'	adeet	'cork wood (sg)'
(b)	rët	'razor blades'	rëët	'razor blade'
(c)	tim	'tree'	tiim	'trees'
(d)	abɛ̈l	'fools'	abɛ̈ɛ̈l	'fool'
(e)	gak	'pied crow'	gaak	'pied crows'
(f)	tɔŋ	'spear'	tɔɔŋ	'spears'
(g)	yöt	'house'	yöötˈ	'houses'
(h)	kot	'thorn trees'	koot	'thorn tree'
(i)	wut	'ostrich'	wuut	'ostriches'

Although sg/pl pairs are some of the best examples for length, length may be found to distinguish words which have no connection with one another. A note to this is that other vowel lengths may seem to be present. Such lengths may be due to the feature of the release of the final consonants or feature of the vowel or word (Duerksen and Agany 1982:1).

Vowel length is a rather difficult feature of the vowels to handle. This results from the fact that vowel length recognition is sometimes obscured by tone. An instance that illustrates this problem is the case of a high tone as opposed to a low tone. The high tone may be erroneously interpreted as a short vowel, while the low one will be interpreted as a long vowel, e.g., *wúut* ostrich vs. *wùut* ostriches.

6.1 Long Vowels at the Lexical Level

In Dinka, vowel length is distinctive. As noted in Duerksen and Agany's analysis, each of the short breathy and nonbreathy vowels can also be long. A long vowel is here regarded as having a duration twice as long as the short. Orthographically a long vowel is written here as *VV* and short vowels as *V*. Long vowels, apart from distinguishing related words at the grammatical level, distinguish words which have no relationship at the lexical level. For example:

(62) (a) ciil 'to slice something'
cil 'to grow'

(b) rïïr 'craftiness'
rïr 'crafty persons'

(c) reem 'to crunch'
rem 'age group'

(d) tëët 'skill'
tët 'picking something'

(e) rɛɛc 'to reject'
rɛc 'spoiling'

(f) rɛ̈ɛ̈c 'badness'
rɛ̈c 'fish'

(g) maan 'to hate'
man 'his mother'

(h) jääl 'going away'
jäl 'guest'

(i) kɔɔc 'to mend'
kɔc 'people'

(j) kɔ̈ɔ̈c 'act of standing'
kɔ̈c 'being weak'

(k) kool 'cattle theft'
kol 'March' (for Rek this would be February)

(l) ṯöök 'losing of breath (death)'
ṯök 'goats'

(m) wuut 'ostrich'
wut 'camp'

6.2 Distribution of Long Vowels in Relation to Consonants

The distribution of long vowels follows that of their counterpart short vowels (cf. examples 9, 10, and 11). The environments in which short vowels occur are those in which the long vowels also occur. It is sufficient here to give examples for only one of the environments (CVC) in which both short and long vowels occur, as in example 62. Especially noteworthy are consonants with features of labialization or palatalization:

(63)
(a) lʷiit 'to peep'
(b) yʷïït 'knocking down repeatedly'
(c) lʷeel 'to say'
(d) rʷëël 'to crane one's neck'
(e) tʸɛɛl 'jealousy'
(f) rʸɛ̈ɛ̈r 'crafty person'
(g) kʷaaṯ 'to drive'
(h) rʸääk 'catastrophe'
(i) pʷɔɔk 'to quench fire with water'
(j) dʸɔ̈ɔ̈r 'womankind'
(k) mʸöök 'oils'

6.3 Distribution of Long Vowels in Relation to Tone

All the long vowels, like the short vowels, occur with different tones in Dinka. But their most frequent occurrence is with sequences of tones. The following examples show the function of tone in distinguishing words with long vowels:

(64) (a) wúut 'ostrich'
wùut 'ostriches'

(b) tʷàañ 'illness'
tʷáañ 'to press'

(c) lɔ̀ɔc 'to do something in haste'
lɔ́ɔc 'kind, generous people'

(d) bóok 'hide'
bòok 'looking after goats or cattle'

(e) rʷéeñ 'dishonest person'
rʷèeñ 'dishonesty'

(f) lʷɛ̀ɛk 'servanthood'
lʷɛ́ɛk 'in the barn'

(g) cíit 'to start a song'
cìit 'hoe handles'

In 64 the examples for each vowel are only representative. All long vowels can also take tone distinctions. The following are occurrences of long vowels with the tones indicated:

(65) (a) lʷiit 'to peep'
(b) tɪ̄it 'to diagnose magically'
(c) lʷeél 'to say'
(d) tëër 'to scramble'
(e) rëët 'to tear'
(f) bëël 'foolishness'
(g) máan 'to hate'
(h) mää̱ 'friendship'
(i) kɔ̄ɔc 'to sew'
(j) kɔ̄ɔ̄r 'kind of tree'
(k) lóoc 'whistling'
(l) yo͞oc 'buying'
(m) pūur 'hoes'
(n) lúuŋ 'to turn upside down'

6.4 The function of Long Vowels at the Grammatical Level

6.4.1 Third Person Singular/Plural Distinction. In Dinka the subject of a present continuative verb is encoded by means of the indicative prefix on the verb, in which case vowel length distinguishes third person singular from third person plural. The third person plural carries the long vowel:

(66) (a) aacam kʷïn
they-eat food
'They are eating food.'

acam kʷïn
he-eat food
'He is eating food.'

(b) aacʸɛ̈m
they-eat
'They are eating.'

acʸɛ̈m
he-eat
'He is eating.'

(c) aatit meţ
they-wait child
'They are waiting for a child.'

atit meţ
he-wait child
'He is waiting for a child.'

(d) aatïït
they-wait
'They are waiting.'

atïït
he-wait
'He is waiting.'

(e) aatem tim
they-cut tree
'They are cutting a tree.'

atem tim
he-cut tree
'He is cutting a tree.'

(f) aatëm
they-cut
'They are cutting.'

atëm
he-cut
'He is cutting.'

6.4.2 Singular/Plural Noun Formation. As reflected in Duerksen and Agany's examples at the beginning of this chapter, vowel length distinguishes singular from plural nouns. Plural formation, however, is not analogous because the formation is not a change of short vowel to long vowel or vice versa. It is a mixture: some singular nouns have long vowels and become pluralized by taking a short vowel, and others do just the opposite. For example:

(67)

	Singular	*Plural*	*Gloss*
(a)	ñiim	ñim	'dorsal fin of fish'
(b)	tiit	tit	'mahogany'
(c)	leŋ	leeŋ	'drum'
(d)	rëët	rët	'razor blade'
(e)	abɛ̈l	abɛ̈ɛ̈l	'fool'
(f)	tak	taak	'kind of bead'
(g)	pät	päät	'big axe'
(h)	tɔŋ	tɔɔŋ	'spear'
(i)	tɔ̈ɔr	tɔ̈r	'spear or hoe handle socket'
(j)	rooŋ	roŋ	'fruit stone'
(k)	löt	lööt	'bell'
(l)	kuur	kur	'mountain'

6.4.3 Prepositional Substitution. In Dinka there are locative names that normally have short vowels. When such nouns occur in sentences in which they are governed by prepositions, they still retain their short vowels. However, when these locative nouns occur in a sentence without a preposition, their locative nature is signalled by the lengthening of the vowels:

(68) (a) Deŋ aci bën ë ror yic.
Deng has come into forest inside
'Deng has come into the forest.'

Deŋ aci bɛ̈n roor
Deng has come forest
'Deng has come to the forest.'

(b) ɖʸɵ̈y ariŋ ɵ̈ rel yic
ant is-running to anthill inside
'The ant is running into the anthill.'

ɖʸɵ̈y ariŋ reel
ant is-running anthill
'The ant is running into the anthill.'

(c) wʷɔndʸɛ amac ɵ̈ Cir kɔu
camp-my is-tethering on Nile along
'My camp is along the Nile.'

wʷɔndʸɛ amac Ciir
camp-my is-tethering Nile
'My camp is along the Nile.'

(d) rɛ̈c atɔ ɵ̈ rʸɛ̈y yic
fish is-present in canoe inside
'The fish is in the canoe.'

rɛ̈c atɔ rʸɛ̈ɛ̈y
fish is-present canoe
'The fish is in the canoe.'

(e) ña aci ca cʸɛɛr ɵ̈ gɵ̈m yic
girl had milk put in gourd inside
'The girl has put milk into the churning gourd.'

ña aci ca cʸɛɛr gɵ̈ɵ̈m
girl has milk put gourd
'The girl has put milk into the churning gourd.

(f) ɖɔk aci rɛ̈c kʷɔt ɵ̈ gɔl yic
boy has fish put in hearth inside
'The boy has put the fish in the hearth.'

ɖɔk aci rɛc kʷɔt gɔɔl
boy has fish put hearth
'The boy has put the fish in the hearth.'

(g) yɔk aci la ë rup yic
cows have go into woodland inside
'The cows have gone into the woodland.'

yɔk aci la ruup
cows have go woodland
'The cows have gone into the woodland.'

These examples demonstrate that vowel length functions at both lexical and grammatical levels.

7 CENTRALIZED VOWELS

Centralized vowels are an area of controversy in the Dinka vowel system. The controversy springs from the fact that the role of vowel centralization in the language is not understood. The extent to which centralization affects the other vowels is not yet understood either. That is why Tucker and Bryan (1966:402-3) differ from Welmers (1973:29) as to the number of central vowels. It is clear that the production of the vowels needs to be thoroughly investigated before definitive conclusions about vowel quality can be reached.

Duerksen and Agany (1982) in their analysis describe a vowel as either 'normal' or 'open'. They deal with centralized vowels under 'open' and say that this quality of vowel is controlled by the muscle of the tongue below the chin. The muscles can be felt to tense and bulge down. They point out that open vowels take effort to produce, and this can be verified by looking up while pronouncing the sound and feeling for the effort being made. They go on to say that various modifications of the vowel are made during the production of an open vowel, such as the enlargement of the pharyngeal cavity (giving the vowel a more hollow or open sound) and greater rounding of the lips for back vowels.

Duerksen and Agany are in agreement with Welmers (1973) on the fact that centralization is a feature of all the vowels in the language. This means that all vowels are seen to become centralized; and with this I concur. I deal with centralization the same as with the other vowel qualities: through an examination of the role it plays in the language at various levels.

7.1 Centralized Vowels and Unreleased Consonants

In Dinka, syllables may be closed with either released [C] or unreleased consonants [C']. The syllable closure determines the character of the preceding vowel: centralized vowels are always associated with unreleased consonants. Consonants that become unreleased include voiceless stops /p, ṭ, t, c, k/ and liquids /l, r/. The association here is simply that syllables checked by these consonants and unreleased have their nuclei reduced. In other words, the vowels followed by tautosyllabic unreleased consonants are shorter than normal. That such a feature of the language represents a generalization is shown in the following comparison of monosyllabic lexical items ending respectively in unreleased and released consonants.

(69)

	Unreleased		*Released*	
	Word	*Gloss*	*Word*	*Gloss*
(a)	dɨṭ'	'bird'	dit	'to beautify'
	rɨc'	'age group'	rïc	'to straighten'
(b)	lɛ̣k'	'pestle'	lek	'are they going?'
	lɛ̣̈k'	'pestles'	lek	'act of informing'
(c)	tạk'	'spleen'	tak	'to think'
	mäṭ'	'my friend'	mäṭ	'smoking'
(d)	rɔt'	'alone'	rɔt	'to pull'
	tɔ̣̈k'	'beginning of winter'		
	tɔ̈k	'mud'		
(e)	pọṭ'	'escaping narrowly'		
	pọṭ	'to slip'		
	kör'	'small dung hearth'		
	kör	'lion'		
(f)	rup'	'woodland bordering plain'		
	rup	'putting tassels on bull's horn'		

A phonological rule would be of the following shape:

V ----> [+ short] / --- [- release] S

7.2 Centralized Vowels at the Grammatical Level

At the grammatical level, centralized vowels [ɤ] occur in verbs used as commands. Thus centralization is not only a purely phonological rule as in example 69; it can also mark the morphological class, imperative (see the final paragraph of this chapter). The following are examples:

(70)

	Shortened		*Non-shortened*	
(a)	cɨl	'rebuke him'	cil	'to germinate'
(b)	tɨŋ	'see it'	tiŋ	'to see'
(c)	lʸɤ̱p	'open it'	lʸep	'to open'
(d)	bɤ̱k	'push it'	bɛk	'to push'
(e)	pɤ̱l	'leave it'	pɛ'l	'to leave'
(f)	cɤ̱m	'eat it'	cam	'to eat'
(g)	dɔm	'catch it'	dɔm	'to catch'
(h)	kɔ̈t̠	'unearth it'	kɔ̈t̠	'to unearth'
(i)	lo̱ñ	'release it'	loñ	'to release'
(j)	bʸɔ̈k	'throw at it'	bʸɔ̈k	'to throw'
(k)	ru̱k	'tie it'	ruk	'to tie'

The other area in which centralized vowels appear in verbs is in the present continuative, where all verbs receive a prefix /a/ (or /aa/ in case of plural subject). Besides the affixation, however, the present continuative affects the vowel in the verb root by reducing its normal duration, thus producing a central vowel. Example 71 contains samples of the application of this rule of centralization on all the known vowels in Dinka. The first column lists *nonpresent continuative* and is labeled "N-C"; the second column lists *present continuative* and is labeled "P-C."

(71)

	N-C	*P-C*	*Gloss*
(a)	tir	atɨr	'is making ... into strips'
(b)	tiŋ	atɨŋ	'is seeing'
(c)	tem	atɤ̱m	'is cutting'
(d)	rem	arɤ̱m	'is crunching'
(e)	til	atʸɤ̱l	'is being jealous'
(f)	tak	atɛ̈k	'is thinking'
(g)	pam	apɑ̱m	'is clapping'
(h)	rɑ̱k	arɑ̱k	'is milking'
(i)	tɔk	atɔ̈k	'is dividing'
(j)	rɔ̈l	arɔ̈l	'is mistakenly hurting'
(k)	coṭ	acɔ̈ṭ	'is polishing'
(l)	ṭöl	aṭɔ̈l	'is finishing'
(m)	gut	agu̱t	'is giving a blow to'

As was seen in 7.1, vowel centralization and unreleased consonants codetermine a contrast at the lexical level. At the grammatical level, centralization is correlated with specific grammatical functions: imperative and present continuative aspect. From these examples, we may tentatively conclude that centralization carries significance in the language. Grammatically, it is important; but at the lexical level, it remains to be determined whether it is vowel centralization or lack of consonant release that varies independently.

8 SUMMARY AND CONCLUSION

Although a complete linguistic analysis of Dinka was not my primary aim, I have included herein a brief description of some outstanding features of Dinka phonology as a background for the rest of the material. Within the framework of the syllable, the twenty consonants and seven nonbreathy vowels established by former linguists as the distinctive sounds of Dinka have, by means of the present study, now been augmented by six breathy vowels, giving a total of thirteen vowels. With vowel tone and length, there are seventy-eight distinct vowel sounds.

Relations between breathy vowels and nonbreathy vowels have been established through study of the formants of the seven nonbreathy vowels and six breathy vowels obtained from sonograms. My goal was to establish their relative positions on the acoustic vowel chart and to evaluate the sonagram data with regard to voice quality differences. One result of this investigation has been that the voice quality difference is now recognized to be partly due to the dilation of the vocal tract for the breathy vowels, resulting from lowering of the larynx and slight aperture of the vocal folds. This dilation gives rise to the absorption of the high frequency energy by the lax pharyngeal walls. The resultant voice quality for the breathy vowels has been found to be "muffled" as opposed to "brassy" for the nonbreathy vowels.

Positionally (in terms of formant frequencies) the two vowel categories have been found to differ. The breathy category is higher and more back than the nonbreathy. The lowering of the larynx in the production of breathy sounds has been seen to be responsible for this change.

During the course of this investigation, I analyzed over two hundred lexical items in short sentences and other frames in order to determine the number of tones in Dinka. The findings have been acoustically confirmed with the PM Pitch Analyzer. Three tones (high, mid, and low) are now claimed for Dinka. This analysis has indicated that tone is important at the lexical level as well as at the grammatical level, and therefore a Dinka dictionary that does not mark tone is inadequate.

Data for vowel length was also studied. Contrast was found at the lexical level. In addition, the roles of vowel length at the grammatical level were examined, resulting in the conclusion that vowel length is significant at both these levels.

I also examined the role played by vowel centralization, using the same procedures as for the other vowel qualities. These studies have shown that central vowels are conditionally determined at the lexical level where they are a result ot the unreleasing of voiceless stops and liquids in syllable-final position. At the grammatical level, centralized vowels are a result of a need to predictably establish a grammatical requirement; i.e., centralized vowels signal verbs in command form, and also occur, along with prefix *a-*, in present continuous verbs.

The main conclusions of this work are the following:

(1) There are six contrastive breathy vowels in addition to the seven nonbreathy vowels already established. The nature of the voice quality difference between the two vowel categories is that of a muffled sound for the higher category ("breathy") as opposed to a brassy sound for the lower category ("nonbreathy"). The muffled voice quality is due in part to dilation of the vocal tract. It can be claimed now that lowering of the larynx is partly responsible for the dilation of the vocal tract. The movement of the larynx, felt by touching the neck during speech, has been used as the determining factor and confirmed by Shaefer's experiments (see sect. 3.2.1). The breathy quality involves additional laryngeal settings as shown by the same experiment.

(2) There are three vowel lengths, normal, short (with centralized vowels), and long; only two of these, normal and long, are contrastive. The short is a conditioned phonetic variant.

(3) There are three lexically significant tones in Dinka: high, mid, and low.

(4) Vowel harmony (see sects. 3.1.3 and 3.2.3.5), which may explain the presence of breathy vowels in other Nilotic languages, does not seem to play the same role in Dinka. The reason for this is that most Dinka words are monosyllabic. Moreover, the words that *are* disyllabic or trisyllabic do not show the harmonic rules claimed in other Nilotic languages. Morphology may be considered by some to be responsible for what appears to be a failure of vowel harmony rules in the few polysyllabic words of Dinka (see examples in sect. 3.2.3.5). Still the application of vowel harmony in Dinka is doubtful; in any case, it does not rule out the distinctive role played by the breathy vowels.

Because I have concentrated on a few major questions, some peripheral issues have not been sufficiently investigated. Among the unsolved areas is principally that of centralized vowels. Further study should discover the conditions giving rise to the unreleased nature of the voiceless stops and liquids in syllable-final position.

If this study contributes nothing else, it is hoped that the illustrative data have established beyond doubt that vowel quality, tone, length, and phonation type (breathiness) are contrastive in Dinka. It has, moreover, suggested something of the phonological number and physiology of these contrasts. Furthermore, this work provides a source of data for future inquiry by linguists who may wish to test these results for themselves. They may be able to avail themselves of instrumental techniques in order to draw their own conclusions.

APPENDIX

Tables 4-6 give formant frequencies for three Dinka speakers.

TABLE 4: First speaker (male, 38, southern)

F_1	F_2	*Word*	*Gloss*
185	1835	riŋ	'running'
125	1750	riŋ	'meat'
310	1620	wel	'guinea fowl'
250	1500	wel	'words'
375	1435	rɛc	'spoiling'
310	1370	rɛc	'fish'
500	1060	man	'his mother'
400	900	man	'hatred'
375	750	tɔŋ	'spear'
310	625	tɔŋ	'bidding good-bye'
250	625	ṭok	'mouth'
240	490	ṭok	'goats'
210	625	wut	'camp'

TABLE 5: Second speaker (male, 28, eastern)

F_1	F_2	*Word*	*Gloss*
200	1850	riŋ	'running'
150	1800	riŋ	'meat'
340	1700	wel	'guinea fowl'
260	1500	wël	'words'
385	1450	rɛc	'spoiling'
340	1400	rɛc	'fish'
530	1130	man	'his mother'
425	1000	män	'hatred'
400	775	tɔŋ	'spear'
340	690	tɔŋ	'bidding good-bye'
260	650	ṭok	'mouth'
260	510	ṭök	'goats'
230	645	wut	'camp'

TABLE 6: Third speaker (male, 42, southern)

F_1	F_2	*Word*	*Gloss*
210	1870	riŋ	'running'
160	1820	riŋ	'meat'
360	1715	wel	'guinea fowl'
280	1510	wël	'words'
400	1460	rɛc	'spoiling'
350	1415	rɛc	'fish'
540	1145	man	'his mother'
450	1025	män	'hatred'
400	760	tɔŋ	'spear'
350	620	tɔŋ	'bidding good-bye'
280	670	ṭok	'mouth'
270	535	ṭök	'goats'
230	645	wut	'camp'

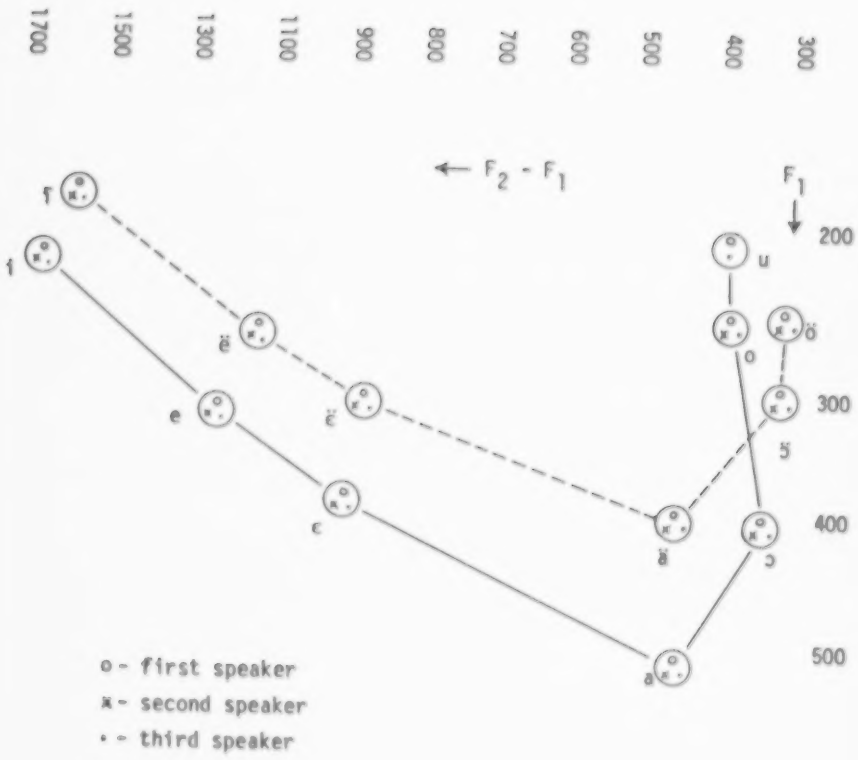

Figure 19. Formant plots for three Dinka speakers

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